OPHTHALMOLOGY

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MANUAL OF OPHTHALMOLOGY

PREPARED BY THE SUB-SECTION OF OPHTHALMOLOGY · SECTION OF SURGERY OF THE HEAD DIVISION OF SURGERY OFFICE OF SURGEON GENERAL, WAR DEPARTMENT, WASHINGTON

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PREFACE.

This manual concerns itself only with some of the commoner diseases and injuries of the eye, and the simpler methods of testing the functions of the organ of sight, including a very brief account of the methods of detecting refractive errors. It makes no pretense to furnish a complete treatise. Therefore physiologic optics and detailed descriptions of the anomalies of refraction and muscle balance and their treatment, ophthalmoscopy, unusual and comparatively uncommon diseases of the eye, and most of the procedures of ophthalmic surgery are omitted. In the paragraphs on treatment a few operative methods are included because they may be regarded in a certain sense as emergency operations. In the appendix are recorded the visual requirements for recruits and drafted men and for applicants in Aviation Service, the tests for ocular malingering, and formulas for the usual collyria, antiseptics, and astringents.

It is hoped that this manual may be of service to the surgeons on duty in the military hospitals, and provide in convenient and condensed form a textbook for those who attend the courses on ophthalmic practice given in the various camps and cantonments. Thanks are extended to W. B. Saunders Co. and P. Blakiston's Son & Co. for the privilege of using illustrations from two of their publications, and to Dr. James Thorington for compiling from his well-known book on Refraction the condensed and brief descriptions of the methods of detecting anomalies of refraction.

CHAPTER I.

FUNCTIONAL TESTING AND EXTERNAL EXAMINATION OF THE EYE.

Visual acuteness.—The first requisite in all ocular examinations is to ascertain the power which the eye has of distinguishing form and size, or of appreciating the external configuration of objects—that is, the *visual acuteness.* This is measured in examinations in the Medical Service of the Army by means of Snellen's test types, and the record is officially made in feet. In civil practice it is the custom, although not a universal one, to employ the metric system in the measurements of visual acuteness and their records. (See appendix.)[1]

If the patient can not decipher the type numbered 200 feet (60 meters) at 20 feet (6 meters), but can decipher this when he is moved closer to the card—for example, to 13 feet (approximately 4 meters)—vision equals 13/CC (in meters 4/60), or 1/15 of normal, etc. Still further depreciation of visual acuteness is recorded by requiring the patient to count the outstretched fingers at various distances, 1, 2, or 3 feet, V=counting fingers at 1 foot, etc. If the ability to distinguish form no longer exists, the *perception of light* should be investigated by alternately screening and uncovering the eye, by illuminating the eye with light reflected from a mirror, or focused upon it with a condensing lens, and the record V=light perception, or no l. p., made.

Causes of impaired vision.—Defective vision may be due to (*a*) errors of refraction; (*b*) cloudy media—that is, opacities in the cornea, lens, and vitreous; (*c*) diseases of the eye, especially of the fundus; and (*d*) diseases of the brain, especially of the visual pathway, which, beginning in the retina, proceeds by way of the optic nerve to the chiasm and optic tracts and the primary optic centers (lateral geniculate bodies, pulvinar of the thalamus, and superior colliculus of the corpora quadrigemina) and onward in fibers which run backward through the posterior part of the internal capsule (visual

[1] For determining the acuteness of vision of illiterate persons, cards are employed on which a number of differently arranged dots are placed, of sizes which should be counted at different distances, or incomplete squares corresponding in size to the test letters, the incomplete sides being turned successively in different directions, may be used.

radiations), pass through this capsule, and spreading out and rising upward, wind outside of the tip of the lateral ventricle, to reach their destination at the lower part of the median surface of the occipital lobe, where the tract terminates in an area in general terms situated about the cuneus and calcarine fissure.

Should the patient's defective vision be improved by requiring him to look through a pinhole (*pinhole test*), it is certainly in part due to refractive error, which is further proved if various lenses tried in succession (convex, concave, and cylindrical lenses) increase the visual power. Examination of the cornea by means of oblique illumination (see p. 26), and of the lens and vitreous by means of the ophthalmoscope (see p. 27), will reveal opacities in the media. Investigation, again with the ophthalmoscope, will discover diseases of the eyeground, and other external examinations with loupe and condensing lens affections of the iris. The cerebral causes of impaired vision must be determined by examination of the visual field (see p. 22), and by the ophthalmoscope, e. g., finding choked disk, and by the concomitant neurological symptoms. In all cases of impaired or lost vision the clinical history is important; that is, whether the loss of sight has been sudden or gradual, whether there are symptoms of general disease, or whether there has been a trauma.

Acute loss of vision is usually due to obstruction of the circulation of the optic nerve or retina; to hemorrhage into the retina, especially in the macular region, its most sensitive area; to nephritis with uremia, to extensive detachment of the retina, usually in a myopic eye; to large hemorrhages into the vitreous, particularly after blows on the eye (see p. 71); to acute inflammation of the optic nerve, particularly of its axial fibers (so-called *retrobulbar* or *axial neuritis*), often caused by exposure to cold, by various toxemias, toxic agents, notably methyl alcohol and infections, and by diseases of the sinuses; to effusions into the orbit pressing on the optic nerve, or to fracture of its bony wall; to rapid rise of intraocular tension, e. g., in glaucoma, and to disease of the brain, especially in the region of the corpora quadrigemina and occipital lobe; or to blows on the head followed by fracture so placed, especially at the base, where the optic nerve or the regions just named may be involved, and to shock; for example, shell shock.

Gradual loss of sight, independent of evident disease of the clear media, may be due to advancing cataract, to degeneration of the vitreous, and the formation of opacities, to affections of the retina (retinitis, hemorrhages), of the optic nerve (progressive atrophy), to affections of the optic nerve depending on toxic agents, e. g., excessive use of tobacco and alcohol, to the chronic types of glaucoma, and to diseases of the spinal cord and brain. This record of some of the

important causes of the slowly developing visual depreciations indicates how thorough the examinations, both local and general, must be in order to determine the etiologic factors.

Accommodation.—In order that the eye shall be able to adapt itself for the perception of objects situated at different distances, a mechanism has been provided which, put into action, provides the necessary power—that is, the power of accommodation—as follows: The ciliary muscle contracting, draws forward the choroid and ciliary processes to which the suspensory ligament of the lens is attached, which is hence relaxed and the crystallin lens, freed from its previous compression, bulges forward and becomes more convex. In effect it adds to its anterior surface another convex lens. Thus by alternate relaxation and contraction of this muscle the eye can be adjusted for all distances between the farthest and nearest point of distinct vision, and the difference between the refractive power of the eye accommodated for its far point and accommodated for its near point constitutes the *range of accommodation.*

The far point is determined by means of the test letters, and if the patient has maximum acuteness for distant vision, this far point (*punctum remotum*, designated r) is infinite. The near point (*punctum proximum*, designated p) is usually found by gradually approaching a card of fine print until the nearest point from the eye at which it still remains distinct is reached.

While looking at the far point the ciliary muscle is relaxed, and the refraction of the eye is at its minimum (designated R), but while looking at the near point the ciliary muscle is contracted to its fullest extent, and the eye is in its conditon of maximum refraction, designated P. Hence the formula is Accommodation or A=P—R.

It is customary to express the power or amplitude of accommodation by that convex lens placed close in front of the eye which would give to rays coming from the nearest point of distinct vision a direction as if they came from the far point. Thus if an individual with normal eyes (*emmetropic eyes*) wishes to see an object, for example, 10 cm. distant, he must exercise his power of accommodation to such a degree that in effect he adds to his crystallin lens another lens of 10 diopters[1]—that is, one having a focal length of 10 cm., i. e., 10 divided in 100=10 cm.

In early life the near point is very close to the eye, the lens being soft and elastic; as age advances the lens becomes harder and less elastic, and the near point gradually recedes until about the age of 70 the power of accommodation entirely ceases. The following table

[1] The standard lens from which all calculations are made is a 1 diopter lens, or one which has a focal length of 100 cm.; a 2 diopter lens would have a focal length of 50 cm., etc.

gives the range of accommodation, according to the years of life, expressed in diopters and the coresponding near point:

10 years, 14 diopters, p=7 cm.
15 years, 12 diopters, p=8.3 cm.
20 years, 10 diopters, p=10 cm.
25 years, 8.5 diopters, p=12 cm.
30 years, 7 diopters, p=14 cm.
35 years, 5.5 diopters, p=18 cm.
40 years, 4.5 diopters, p=22 cm.
45 years, 3.5 diopters, p=28 cm.
50 years, 2.5 diopters, p=40 cm.
55 years, 1.75 diopters, p=55 cm.

Abnormal or lost accommodation.—In normal eyes, although with each year the power of accommodation grows gradually less, the near point of distinct vision does not usually recede inconveniently until the age of from 45 to 50 is reached, and *presbyopia* is established. The deficiency must be supplied with a convex glass (reading glass). The failure of accommodation begins earlier if the patient is farsighted (hyperopic) and is correspondingly delayed if the patient is nearsighted (myopic), and if he has a sufficient degree of nearsightedness (about 3 D.) his eyes never become presbyopic and he can always read without the aid of convex glasses.

Accommodation is often insufficient and ill-sustained, even in young eyes, owing to hyperopia (farsightedness), and astigmatism, and is in these circumstances the cause of much ocular distress and headache, correctible with suitable glasses.

The ciliary muscle is supplied by the oculo-motor (third) nerve, and when this is paralyzed we have the condition of *cycloplegia*, which may or may not be accompanied by dilatation of the pupil (*mydriasis*), and which may be complete or partial (*paresis of accommodation.*)

Common causes of paralysis of accommodation are diphtheria, tonsillitis, acquired syphilis, spinal cord diseases, diabetes, infectious fevers, e. g. typhoid fever, disorders of metabolism, diseases of the accessory sinuses, dental infections, ptomain poisoning, fish and meat poisonings. Cycloplegia is not infrequent after blows on the eye, and can be produced artificially by the various so-called mydriatics, e. g. atropin, homatropin, scopolamin, etc. In all ocular examinations it is important to measure accommodation, and if defective a careful search made to determine the cause.

Simpler methods of testing the exterior ocular muscles.—The movements of the eyes are controlled by four straight muscles, that is, four attached to each eye, namely, the superior, inferior, external, and internal recti, and by two oblique muscles, that is, two attached to each eye, namely, the superior and the inferior oblique.

Expressed in the simplest terms, and omitting all reference to oblique and torsion movements of the globe, the eye is turned upward by the superior rectus and the inferior oblique, downward by the inferior rectus and the superior oblique, outward by the external rectus, and inward by the internal rectus. The third or ocular nerve supplies all of these muscles except the superior oblique, which is supplied by the fourth nerve, and the external rectus, which is supplied by the sixth nerve.

Under normal conditions there is coordination in the movements of the eyes, and the movement of one eyeball is associated with that of its fellow. In other words, both eyes are used for seeing (*binocular vision*) and are so adjusted that the image of the object regarded falls simultaneously on both maculas, the macula being the most sensitive portion of each retina, and there is *binocular fixation*. An imaginary line drawn from the object regarded, or "fixed," to use the technical term, to the macula lutea, is called the *visual line*, or the *visual axis*.

The desire for single vision with the two eyes (*binocular single vision*) which depends upon the blending of two sets of visual sensations, or *fusion*, as it is called, is believed to be the origin of the impulse which directs the movements of the eyeballs, especially in association in the same direction, that is, if one eye is turned to the right, the other eye is also turned to the right and to the same extent as its fellow; if one eye is elevated the other is also elevated; if one eye is depressed, the other is also depressed, etc.

Under pathologic conditions this association in the movements of each eye is disturbed, and double vision, or *diplopia*, results, and the visual axes, which normally are maintained parallel, tend to deviate, and there is *latent squint* or *deviation*, usually called *heterophoria*, or there is *manifest deviation*, usually called *strabismus*, and sometimes denominated *heterotropia*.

Heterophoria.—Whenever there is only a tendency to deviation of the visual axes, the strong desire on the part of the patient maintains binocular single vision, and this tendency can be detected only by special tests. The simplest of these consists in the use of the Maddox rod, or a rod of white or red glass mounted on a cell which will fit in a trial frame. The patient is seated 5 or 6 meters from a small circle of light, or a candle flame, and the Maddox rod placed before the right eye so that it is horizontal. In these circumstances the patient will see a vertical line of light with the right eye, and the flame or circle of light with the left eye. If the flame and the line of light coincide, there is no tendency to deviation of the visual axes in the lateral direction. If, on the other hand, the line of light lies to the right of the flame, the visual axis tends to turn in, and the condition is named *esophoria*. Should the line of light lie on

the left of the flame, there is a tendency for the visual lines to deviate outward, and the condition is named *exophoria.* The Maddox rod is next turned so that its long axis is vertical, and the patient sees a horizontal line of light. If the line and the light coincide, there is no tendency of the visual axis of one eye to be directed above that of the fellow eye. Should the line of light lie below the flame, or should it lie above the flame, the condition is called *hyperphoria*, *right hyperphoria* in the first instance, and *left hyperphoria* in the second instance. Coincidence of the line and the flame, either in the vertical or the horizontal position, is the normal state of affairs, and is designated *orthophoria.*

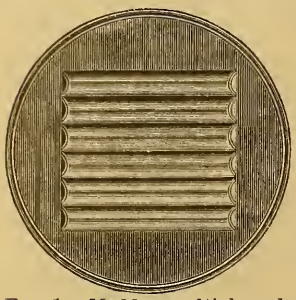

FIG. 1.—Maddox multiple rod.

Another way of testing this tendency for deviation of the visual lines, or hyperphoria, is by means of prisms, as follows:

Prism tests.—A small flame is placed against a dark background at 5 or 6 meters from the patient and on a level with his eyes. In an accurately adjusted trial frame a prism of 7° is inserted, base down, before one eye—for example, the right. Vertical diplopia is induced, and the upper image belongs to the right eye. If the flames stand one directly over the other there is no inclination to divergence or convergence. If

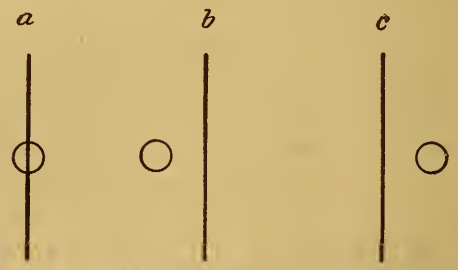

FIG. 2.—Maddox's rod test for horizontal deviation. The rod is before the right eye. *a,* The line passes through the circle of light—orthophoria. *b,* The line passes to the right of the light—latent convergence, or esophoria. *c,* The line passes to the left of the light—latent divergence, or exophoria.

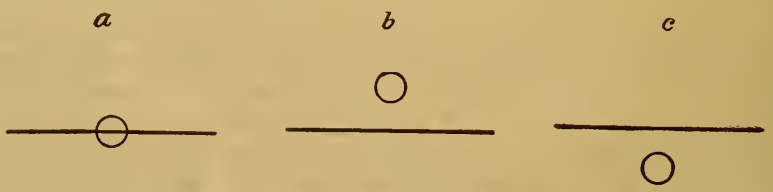

FIG. 3.—Maddox's rod test for vertical deviation. The rod is before the right eye. *a,* The line passes through the circle of light—orthophoria. *b,* The line passes below the light. The upper image belongs to the left eye—right hyperphoria. *c,* The line passes above the light. The upper image belongs to the right eye—left hyperphoria.

the upper image stands to the left, there is exophoria; if to the right, esophoria. That prism placed with its base in or out before the

left eye, according to circumstances, which brings the two images into a vertical line, measures the degree of the deviation.

In order to test the functions of the vertical muscles at a distance of 6 meters the patient is seated as before and a prism of sufficient strength to induce lateral diplopia is placed before one eye—for example, the right—i. e., with its base toward the nose. If the images are on the same level, no deviating tendency is present. If, for example, the right image rises higher than the other, the visual line of the right eye tends to be lower than that of its fellow and there is hyperphoria. That prism, placed with its base down before the left eye, which restores the images to the horizontal level, measures the degree of deviation.

These tendencies to deviation of the visual axes, corrected only by a strong effort on the part of the patient, interpret themselves in various symptoms—headache, vertigo, nausea, and functional nervous disturbances, even intestinal derangements—and their correction by means of suitable glasses which neutralize the refractive error, associated with prisms to neutralize the tendency of the visual axes to deviate, form an important part of ocular therapeutics.

Manifest deviation of the visual axes, or *strabismus*, appears in two varieties:

I. **Paralytic strabismus, due to paralysis of an ocular muscle.**—The important symptoms are strabismus, limitation of movement or rotation in the direction in which the paralyzed muscle normally turns the eye, and diplopia.

To test the extent of the limited movement, or to ascertain whether there is any limitation in the normal rotation, require the patient to regard the surgeon's finger, which is held before him at a distance of 15 inches, and to follow with his eyes, his head remaining stationary, this finger while it is moved to the right, to the left, and up and down. In outward rotation the outer margin of the cornea should reach the external canthus; in inward rotation it should reach the internal canthus. In upward rotation the defect in movement is estimated by the extent to which the sclera is exposed between the lower margin of the cornea and the margin of the lower lid in comparison with a similar exposure of the fellow eye; in downward rotation the defect in movement is estimated by the extent of the cornea overlapped by the lower lid in comparison with the overlapping in the fellow eye.

These tests suffice to distinguish a paralyzed straight muscle (external, internal, superior, or inferior rectus), and will usually suffice to detect a lagging movement in any one of the same muscles. The strabismus in complete paralysis of a straight muscle is usually quite evident, being *internal* or *convergent* if the external rectus is para-

lyzed, *external* or *divergent* if the internal rectus is paralyzed, *downward* if the superior rectus is paralyzed, and *upward* if the inferior rectus is paralyzed.

During these rotation tests the examiner should watch for the development of *nystagmus*, or a rapid, rhythmic movement of the eye, which may be vertical, lateral, rotary, or mixed; almost always bilateral, it is usually of the horizontal type. Excluding congenital cases, albinism and occupational nystagmus (miners' nystagmus), it may indicate affections of the brain (tumor of the cerebellum), of the spinal cord (multiple sclerosis), and of the labyrinth of the ear. The various types of nystagmus are developed in the routine Barany tests, which have assumed great importance in cerebral localization and in the examination of aviators. Nystagmic jerkings, differing from true nystagmus, frequently develop when the limits of the ocular rotations are reached, especially if the follow-on movements are frequently repeated.

To study or elicit diplopia, especially if the muscle is not completely paralyzed (paresis of the muscle), place before the right eye of the patient a red glass, and require him, both eyes being open, to regard a candle flame or small electric-light bulb held by the examiner at a distance of 4 meters. Two images will be seen, one red, belonging to the right eye, and one white, belonging to the left eye. If the images are side by side in a horizontal line, there is *horizontal diplopia;* if they stand one above the other in a vertical line, there is *vertical diplopia;* if one image is tilted or oblique, there is *oblique diplopia.* If the right image, in this instance the red image, pertains to the right eye, and the left image, in this instance the white image, pertains to the left eye, the diplopia is designated *simple* or *homonymous diplopia;* if the right image pertains to the left eye and the left image to the right eye, the diplopia is *crossed* or *heteronymous.*

If there is lateral or horizontal diplopia, the patient holding his head steady, is required to look to the right at the test light moved in the same direction, and if the diplopia increases in this direction, i. e., the images separate more widely, and is homonymous, the right external rectus is affected; if in the same circumstances the diplopia is crossed, the left internal rectus is affected. If, in the same way, the patient looks to the left and the diplopia increases in this direction, and is homonymous, the left externus is affected; if in the same circumstances the diplopia is crossed, the right internal rectus is affected.

If there is vertical diplopia when the patient regards the test light held in the upper field, and this diplopia increases the more he looks up and to the right, and the image of the right eye is above, the right superior rectus is affected; if, however, in the same circumstances, the image of the left eye is above, the left inferior oblique is affected. If under similar conditions the vertical diplopia increases when the

patient looks up and to the left, and the image of the right eye is above, the right inferior oblique is affected; if, however, in the same circumstances, the image of the left eye is above, the left superior rectus is affected. The lower field is next investigated, and in exactly the same manner. If the vertical diplopia increases on looking down and to the right, and the image of the right eye is below, the right inferior rectus is affected; if, however, the image of the left eye is below, the left superior oblique is affected. If the vertical diplopia increases on looking down and to the left, and the image of the right eye is below, the right superior oblique is affected; if, however, the image of the left eye is below, the left inferior rectus is affected.

On finding a palsy or paresis of an exterior ocular muscle, there should be a thorough examination of the patient, as it may be produced by an orbital disease, for example, cellulitis, periostitis, or sinus disease, or may be due to an intracranial lesion, especially at the base. Syphilis causes about one-half of the exterior ocular muscle palsies; others are caused by rheumatism, gout, influenza, diabetes, toxic agents, and ptomaines. They also occur frequently in locomotor ataxia, paretic dementia, and disseminated sclerosis, and may be found in association with brain hemorrhage, basilar meningitis, abscess from middle-ear disease, pituitary body affection, and various intracranial pressure lesions, and from trauma directly to the orbit, or causing fracture of the skull. The discovery of the muscle affected serves as an important aid in determining the seat of the brain lesion.

II. Concomitant strabismus is characterized by the power of the squinting eye to follow the movements of the other eye in all directions and usually by the absence of diplopia, because the false image is suppressed. In these particulars it is evident that it differs entirely from a complete paralytic strabismus.

There are several varieties, the chief ones being *convergent* or *internal strabismus*, the ordinary "crossed eyes," and *divergent* or *external strabismus*, often vulgarly known as "wall-eyes." Also the squint may be *periodic* or *constant*, and may be *monocular*, that is, the same eye always deviates when the fellow eye fixes an object, or *alternating*, that is, either eye is used indifferently for fixation.

Convergent strabismus usually begins between the third and fourth year of life, but may occasionally be noted shortly after birth. If it is delayed until after the fifth year, it is usually alternating, and the vision of each eye is normal. In the monocular squints the vision of the deviated eye is almost always very defective. The refractive error of convergent strabismic eyes is generally hyperopic (farsighted); that of divergent strabismic eyes generally myopic (nearsighted).

Causes of concomitant squint.—Exactly why and how these types of concomitant squint arise is even at this time not definitely decided. Three factors are important in this regard, which briefly summarized are these: Errors of refraction, which disturb that relation which ought to exist between accommodation (p. 11) and convergence, or the turning inward of the eyes, so that the point of convergence and the point accommodated for coincide; inequality in vision, or an amblyopia (defective vision) of one eye; and defective development of the fusion sense (p. 11).

Treatment of convergent squint consists in the most accurate measurement of the refractive error, and glasses should be adjusted as early as possible, which adjustment is perfectly feasible in very young children; this alone will often straighten the eyes, and it is the duty of physicians to deny the ignorant assertion so constantly made that the child "will outgrow the squint," or that it is "too young to wear glasses." The good results are materially enhanced if in addition the amblyopic eye is forced to make an effort to see by occluding the fixing or better seeing eye, and by educating the fusion faculty by means of stereoscopic exercises. If these measures do not succeed, and they should be faithfully tried for long periods of time, the eyes may be straightened by operation—tenotomy of the internus, or preferably advancement of both external recti. Divergent squint is managed, in addition to adjusting suitable glasses, by operation, tenotomy of the externi, usually insufficient, and advancement of the interni.

Pupil reflexes or reactions and simple methods of testing them.—In the center of the iris there is a circular aperture—the *pupil.* Its movements, or more accurately the movements of the iris in relation to this aperture, depend upon the activities of two muscles, viz, the *sphincter of the pupil*, which is the well-marked circular band of involuntary muscle fibers which surrounds the pupillary margin of the iris, and the *dilator of the pupil*, which consists of radially placed fibers on the posterior surface of the iris. Together these structures constitute the *pupil muscles.* Each has a separate motor nerve supply—the sphincter being supplied by the third or oculomotor nerve, and the dilator by the sympathetic nerve.

The pupil movements (really the mobility of the iris) are controlled by these pupil muscles, which are set in motion either by reflex stimuli, or by association with other voluntary or involuntary movements, and are known as the *pupil reactions* or *pupil reflexes.* The important ones are as follows:

(1) **The direct light reflex of the pupil,** or that contraction of the pupil obtained by illuminating the pupil area. It may be tested as follows: The patient is seated before a window in diffuse daylight, and gazes steadily in the direction of the light; next the eyes are

covered with a card, and after a few seconds the cover is removed from one eye, into which the light now falls and causes, if conditions are normal, a rapid and complete contraction of the exposed pupil. The same procedure is repeated with the other eye. Following this test artificial illumination should be used, and with the ophthalmoscopic mirror light should be reflected into each eye in turn and its effect on the pupil noted, or a condensing lens, such as is used in oblique illumination, may be used, or, best of all, a narrow beam of electric light obtained from the bulb of an electric ophthalmoscope. In ordinary diffuse daylight the pupil, the accommodation being at rest, varies in size from 2.5 to 5.5 mm., an average size being about 4 mm. It can be measured with an instrument called a *pupillometer*, which consists of a scale of circles held close to the eye, the scale being rotated until that circle which matches the pupil in size is reached.

(2) **The consensual light reflex**, or **indirect reflex action of the pupil**, or that contraction of the pupil of one eye which is evident when the pupil area of the opposite eye is illuminated. The test is made as follows: One eye is completely excluded from the source of illumination, and the other shaded in such a manner that the pupil can be observed beneath the cover. The completely excluded eye is now uncovered and the light directed into its pupil, the contraction which occurs in the shaded pupil being at the same time observed. Although the pupil of one eye acts under normal conditions in unison with its fellow, the direct and indirect reactions are not equal in intensity.

(3) **The accommodation and convergence reaction**, called also the **associated action of the pupil**, or that contraction of the pupil which takes place when the visual axes converge upon a near point. The test is made as follows: The patient is required to look into distance and then quickly to direct his eyes at a near object—for example, the point of a pencil held at a distance of about 10 cm. Under normal conditions a contraction of the pupils will occur—that is, the sphincter of the iris contracts in association with the ciliary muscle and the internal recti. The associated movement of the pupil is much more closely connected with convergence than with accommodation.

(4) **The sensory reflex of the pupil**, sometimes called the **skin reflex**, or the **pain reaction**—that is, a slight dilatation of the pupil which occurs on stimulating sensory nerves. It may be tested by pinching the skin of the neck, or, better, by applying to it a faradic brush.

Pupillary pathways.—The fibers of the pupil-reflex tract begin in the retina, proceed in the optic nerves, reach the optic chiasm, where they undergo partial decussation, enter the optic tracts, which they leave just in advance of the external (lateral) geniculate body, and reach the third nerve nucleus. This route constitutes the *afferent pathway*.

From a special part of this nucleus the pupil-constricting fibers proceed in the main trunk of the oculomotor nerve to the orbit, pass into the branch which supplies the inferior oblique, leaves this by way of the twig which constitutes the short root of the ciliary ganglion, and arrive finally at the sphincter of the iris by the short ciliary nerves which after penetrating the sclerotic pass forward in the choroid and ciliary body to the iris. This route constitutes the *efferent or miotic pathway.* Stimulation of it produces contraction of the pupil; section or paralysis of it moderate dilatation.

The path by which the pupil fibers leave the optic tract in advance of the external geniculate body to reach the third nerve nucleus is not definitely known; it probably passes through part of the corpora quadrigemina, and it is also probable that there is a connection over the median line between the two sphincter nuclei in the third nerve nucleus. This route constitutes the *connecting pathway* between the afferent and efferent tracts which have just been described.

The pupil-dilating fibers begin in a center in the medulla (perhaps in a point within the aqueduct), proceed into the lateral columns of the spinal cord, leave the cord by the roots of the first, second, and third dorsal nerves, follow the branches by which they communicate with the superior sympathetic cervical ganglion, pass upward in its ascending branch, reach the plexus around the internal carotid and Gasserian ganglion, and arrive at the iris through the nasal branch of the ophthalmic nerve and its long ciliary nerves, which perforate the sclerotic, to be distributed to the ciliary body and iris. This route constitutes the *mydriatic pathway.* Stimulation of it causes *dilatation of the pupil;* section or paralysis of it *moderate contraction.*

The direct light reflex of the pupil is the result of an active constrictor effect, the stimuli passing along the afferent pathway to the sphincter center in the third nucleus, and from there by the efferent pathway to the termination of the miotic fibers in the iris.

The consensual or indirect light reflex of the pupil occurs because the stimulus passes to the opposite eye, either by reason of the decussation of the fibers in the chiasm or because of its transference from one nucleus to the other.

The sensory reflex of the pupil is a dilator reflex called into existence by various sensory stimuli, and is due in part to augmentation of the dilator tone through the sympathetic.

The convergence and accommodation reaction of the pupil is not a reflex, but an associated movement, and depends upon the effect of a stimulus which reaches the convergence center in the third nucleus and is diffused to the cells which innervate the ciliary muscle.

Abnormal pupil reactions.—The usual departures from the normal are interpreted by inequality, dilatation, contraction, and loss of the

natural response to the various stimuli—light, convergence, and accommodation.

Unequal pupils (anisocoria) are occasionally seen in health. If there is recent wide dilatation of one pupil and no disease of the eye, the instillation of a mydriatic may be suspected. Unequal pupils occur in eyes with widely dissimilar refraction, if one eye is blind, in aneurism, pulmonary tuberculosis, dental disease, sinusitis, traumatism, and in diseases of the nervous system. If the disease is cerebral, the inequality denotes unilateral or focal brain disease. Anisocoria is not uncommon in tabes, disseminated sclerosis, and paretic dementia.

Dilatation of the pupils (mydriasis).—Pupils dilate abnormally in fright, emotion, deep inspiration and expiration, advanced anemia, and in conditions which produce great nervous depression, but their response to the usual stimuli is not checked.

Pupils are dilated by the various mydriatics—atropin, scopolamin, homatropin, cocain, etc., and excepting with cocain there is also paralysis of the ciliary muscle.

Pupils are dilated in various diseases of the nervous system—brain and spinal cord. The brain lesions which cause dilatation of the pupil are usually extensive; for example, pressure on the cerebrum, late stages of meningitis, cerebral softening, hemorrhage into the peduncle, etc. The spinal-cord lesions which cause dilatation of the pupil are usually of such a nature that they cause irritation of the part; for example, hyperemia of the cervical cord, early spinal meningitis, tumor of the cord, early locomotor ataxia, and paretic dementia.

Lesions of the optic nerve, or elsewhere situated, which cause its complete atrophy, produce complete immobile dilatation of the pupil (*amaurotic immobility*). Should, for example, one optic nerve alone be atrophic, the pupil would be larger than the one on the unaffected side, would not respond to direct light stimulus, but the accommodation-convergence movement and indirect reaction would remain intact. Such unilateral pupil immobility may be seen in atrophy of one nerve from pressure on it of orbital exudation, from fracture of the orbit and injury of the nerve, or fracture through the optic foramen or base of the skull.

Contraction of the pupils (miosis).—Pupils contract abnormally in certain fevers, in plethora, venous obstruction, pulmonary congestion, in sleep, etc., but their response to the usual stimuli is not abrogated, although it may be difficult to elicit. They are also contracted if the iris is congested and sometimes by iris traumatisms. Pupils are contracted by the miotics—eserin and pilocarpin.

Pupils are contracted in various diseases of the nervous system—brain and spinal cord. The brain lesions which cause contraction of the pupil are usually in the irritative stage; for example, inflamma-

tion of the brain and meninges in their early stages, brain abscess, beginning sinus disease, small cerebellar hemorrhages, early cerebral apoplexy, and in the early stages of cerebral neoplasms.

Spinal-cord lesions which cause contraction of the pupil are usually in the stage in which the part is depressed or even destroyed, for example, disease or injury of the cord above the dorsal vertebra, locomotor ataxia, paretic dementia (*spinal miosis*). Certain pupil phenomena deserve especial mention.

Argyll-Robertson pupil (reflex immobility).—The pupil to which this name has been given is one which has lost its direct and indirect light reflex, but retained its accommodation-convergence reaction. Usually bilateral, the pupils are generally, but not always, miotic and have an irregular contour, and are not infrequently unequal. This condition of the pupil is constantly seen in locomotor ataxia, paresis, and syphilis of the nervous system; rarely it has been seen in trauma and alcoholism. The lesion is probably in the fibers passing from the proximal end of the optic nerve to the oculo-motor nuclei, perhaps in the ciliary ganglion.

Absolute immobility of the pupil (pupillary rigidity).—As the name implies, the pupils do not react to direct and indirect light, nor to accommodation and convergence. Such a condition could be caused by a lesion of the efferent pathway from the sphincter nucleus to the sphincter of the iris, or after a blow on the eye (*traumatic miosis*). Precisely the opposite condition (*traumatic mydriasis*) may also follow blows on the eye. If there is associated paralysis of accommodation due to a nuclear lesion, the condition is suggestive of syphilis, locomotor ataxia, paresis, and some forms of intoxication.

Pupil changes in lesions of the sympathetic nerve.—If there is an injury of the cervical sympathetic, for instance, a stab or bullet wound of the neck, or pressure upon it from, enlarged cervical glands, or an aneurism, there will result contracted pupil with lessened light reflex, narrowing of the palpebral fissure, slight sinking inward of the eyeball (*enophthalmos*), and ptosis, and if seen early, flushing of the face and unilateral sweating. If the lesion should be one which caused an irritation, not a palsy of the sympathetic, there would be a moderate dilatation of the pupil on the corresponding side.

This summary of the pupil changes necessarily omits a number of the unusual reactions or failures of reaction, but is a sufficient guide to indicate how thorough the examination must be in the presence of any anomaly of the pupil reflexes.

Simpler methods of determining the visual field.—When the eye is directed to a stationary point, not only is the object thus fixed visible, but also all other objects contained within a given space,

which is large or small in proportion to the distance of the fixation point from the eye. This space is the *field of vision.*

Its limits may be approximately ascertained as follows: Place the patient with his back to the source of light, and have him fix the eye under examination, the other being covered, upon the center of the face of the observer or upon the eye of the observer which is directly opposite his own, at a distance of 2 feet (60 cm.). Then let the surgeon move his fingers in various directions midway between himself and the patient, on a plane with his own face, until the limits of indirect vision are determined, controlling at the same time the extent and direction of the movements by his own field of vision. This method suffices to discover any considerable limitation, and, in the event of such discovery, should be supplemented by a more exact procedure.

If it is desired to have a map of the field not larger than 45° in extent, let the patient be placed 25 cm. from a blackboard, which may be conveniently ruled in squares, and fix the eye under observation upon a small white mark. The observer then moves the test object—a piece of white paper 1 cm. square, affixed to a black handle—from the periphery toward fixation, until the object is seen. If eight peripheral points are marked and afterwards joined by a line, a fair map of the field of vision will be obtained.

Should these tests indicate that there are departures from those limits which are considered normal, for example, general contraction, contraction limited to one or other side, absence of a sector or quadrant, or absence of the entire right or left half of the field, the simpler tests described should be supplemented with an examination made with the *perimeter*, which consists essentially of an arc marked in degrees, which rotates around a central pivot, that at the same time may be the fixing point of the patient's eye, which is placed 30 cm. distant in the center of curvature of the perimeter arc. The test object, 1 to 2 cm. in diameter, affixed upon a carrier, is moved from without inward, and the point noted on each meridian where it is recognized. The result is transcribed upon a chart, prepared by having ruled upon it radial lines to correspond to the various positions of the arc, and concentric circles to note the degrees. (Fig. 4.) The test objects are squares of white, blue, red, and green.

It must be remembered that loss of the function of any portion of the retina is interpreted by a defect in the visual field of the opposite side; thus, if the lower half of the retina is inactive, the upper half of the field is deficient or wanting, etc. In addition to the defects already noted, certain dark areas, often at or near the center of the field, may be found, especially by employing small colored tests. These are known as *scotomas* and, if detectable only with

colors, *color scotomas*. The significance of visual defects will be referred to in the description of the various ocular diseases, as may be required.

Absence of the right half of each visual field (*right lateral hemianopsia*) or of the left half of each visual field (*left lateral hemianopsia*), or of the temporal half of each field (*bitemporal hemianopsia*) would indicate, in the first instance, a lesion of the left optic tract or pathway posterior to the chiasm; in the second instance a lesion in the right optic tract or pathway posterior to the chiasm; and in the last instance a lesion in the crossed fasciculi of the chiasm.

Color blindness.—Congenital disturbance of the *color sense*, or the power which the retina has of perceiving colors, is of comparatively frequent occurrence, having been found in about 3 per cent of the examinations made for this purpose among men. Complete color blindness is very rare, but partial color blindness is common, the most usual types being *green blindness* (red-green blindness, according to Hering), and *red blindness* (red-green blindness, according to Hering). Blue blindness, or yellow-blue blindness, and violet blindness also occur but are rare, especially the latter.

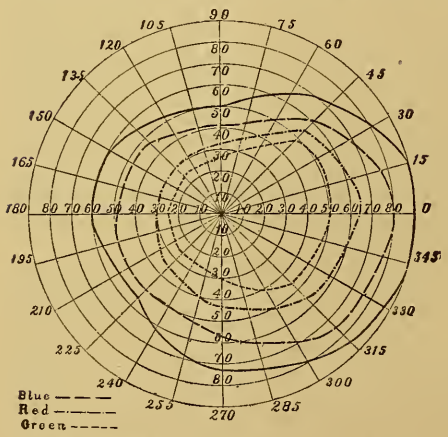

FIG. 4.—Diagram of the field of vision for blue, red, and green. The outer continuous line indicates the limit of the form field; the broken lines, the limits of the color fields.

A person afflicted with *green blindness* (red-green blindness, according to Hering), confounds light green with dark red, does not recognize a dark-green letter on black, but recognizes well a red one on the same background. The most frequent confusions are brown with dark green, red with green, red with orange, red with yellow, red-yellow with green-yellow, bluish-green with purple.

A person afflicted with red blindness (red-green blindness, according to Hering) confounds light-red colors with dark green and can not see a dark-red square on a black ground. The most frequent confusions are: Red with dark green, yellow with green, green with bright red, bluish green with gray, orange with greenish yellow or with red, orange with golden yellow, with grass green, or with red, purple with blue.

Testing for color blindness.—Many methods of examining for color blindness are in use, for example, matching colors, conveniently used in the form of colored yarns (Holmgren's).

The set of worsteds contains three large test-skeins, namely: (1) *light pure green*, (2) *rose-purple*, (3) *red;* and 150 small skeins of the following colors: Red, orange, yellow, yellow-green, pure green, blue-green, blue, violet, purple, pink, brown, and gray. In addition, there are several shades of each color, and a number of gradations of each tint, from the deepest to the lightest. The person examined is required to select from the pile of skeins those nearly resembling the test skein in color, and to place them by the side of the sample.

To control the various wool tests, lanterns for detecting color blindness are employed, useful models being those designed by William Thomson, Charles H. Williams, and Eldridge Green of England. Full directions for using these lanterns accompany them. In our Army Aviation Service the Jennings test is official. Directions for using the test, which is convenient, simple, and furnishes a self-made record of color perception, accompany each set.

Direct inspection of the eye.—The surface of the lids should be examined for swollen superficial veins, a common index of inflammation of the globe; their edges for inflammation, parasites, and misplaced cilia; the puncta for permeability, pressure at the same time being made over the lacrimal sac in order to express from it through the puncta any contained fluid; the upper and the lower conjunctival cul-de-sac for accumulated secretion, granulations, and foreign bodies; the palpebral conjunctiva for hardened secretion in glands; the caruncles for swelling, attached foreign bodies, and irritation by incurved cilia; and the conjunctiva for the information to be derived from its blood vessels.

In order to evert the lid, observe the following rule: Require the patient to turn the eye strongly downward, seize gently the central eyelashes of the upper lid between the index finger and thumb of the left hand, draw the lid downward and away from the ball, place the point of the thumb of the right hand above the tarsal cartilage of the lid which is to be everted, the remaining fingers being steadied on the brow, and, by a quick movement, turn the edge of the lid over the point of the thumb, while this is simultaneously depressed. During the entire maneuver insist upon the downward direction of the patient's eyes; otherwise the lid can not be turned without undue force and pain. When there are no lashes on the upper ciliary margin, the lower lid should be pushed beneath the edge of the upper in such a manner that it acts as a wedge on which the superior lid is then everted. In this manner the lid can be everted with the fingers of one hand. Care should be exercised to expose the tissues of the upper cul-de-sac which lie beneath the folded lid by making a second eversion of this folded lid, or by taking a probe and, from the outside, pushing the concealed fold into view.

The surgeon should inspect the skin of the face and forehead, examine the orbits by palpation, ascertain the action of the orbicularis by causing the patient to close his eyes as if in sleep, and study the length, width, and symmetry of the palpebral fissures and the condition of the commisural angles.

Examination of the blood vessels of the conjunctiva is important, and the following summary of their alterations in various conjunctival, corneal, and iritic inflammations will be found to be useful. There are three systems:

System I.—Posterior conjunctival vessels, whose congestion produces a bright red, velvety color, moving, on pressure of the eyelids, with the shifting of the conjunctiva, usually associated with mucopurulent secretion, and indicating conjunctivitis. Conjunctival congestion is most intense at the fornix and in its neighborhood and decreases as the corneal margin is approached.

System II.—Anterior ciliary vessels, composed of perforating and nonperforating arteries and veins. The perforating arteries, which supply the sclerotic, iris, and ciliary bodies are the branches seen in health entering about 5 mm. from the corneal margin, their points of entrance, in dark-complexioned people, often being distinctly tinted.

The nonperforating (episcleral) branches, invisible in the normal eye, produce, when congested, a pink zone surrounding the cornea ("ciliary congestion," "circumcorneal zone"), not moving on pressure of the lids with the shifting of the conjunctiva, unassociated with purulent discharge, and one indication of iritis. Ciliary congestion is most distinct around the corneal margin and lessens as the fornix is approached. The most congested circumcorneal zone is least involved in pure conjunctival congestion.

The perforating veins and their nonperforating (episcleral) twigs, when congested, create a zone of dusky hue, often a symptom of glaucoma, or appear in unequal, deep-seated patches of lilac or violaceous color, indicating cyclitis or scleritis.

System III.—Anterior conjunctival vessels and the plexus of capillaries surrounding the cornea, derived from anterior ciliary vessels through whose numerous small branches anastomosis between Systems I and II takes place. Their congestion produces a circle of bright-red injection, often partly on the cornea, a sign of inflammation of this membrane, and typified in the early vascular stages of interstitial keratitis.

Oblique illumination.—The surgeon places the patient 2 feet from the source of illumination, and focuses a beam of light with a 2 or 3 inch lens upon the cornea, at the same time observing the surface under examination through a lens of the same focal distance, held be-

tween the thumb and forefinger, the disengaged fingers being utilized to elevate the upper lid.

The distance of the lens must be varied slightly, according as the cornea, iris, or crystalline lens is brought within its focus, the patient being required to look up, down, and to either side, while all the anterior surfaces and media of the eye are illuminated. In order to detect foreign bodies in the cornea, the light should be directed at an acute angle. If the posterior pole of the lens is to be examined, the light is thrown perpendicularly into the pupil, the surgeon placing his eye in the same direction without interfering with the light.

By this method minute abrasions, previously undetected foreign bodies, channels of old vessels, and other corneal changes may be examined. The character of the aqueous humor, the depth of the anterior chamber, the surface of the iris, the presence of synechiæ, small tumors, atrophic fibers, and persisting pupillary membrane are evident, and, finally, opacities in the anterior capsule and axis of the lens are discoverable.

Use of the ophthalmoscope in detecting defects in the ocular media.—To enhance diagnostic accuracy in the search for opacities and defects in the cornea, lens, and vitreous, the ophthalmoscope should be employed as follows, using either an electric or an ordinary ophthalmoscope:

A +7 D. or +16 D. lens is turned into place behind the ophthalmoscopic mirror, and the examiner, looking through the sight hole, brings the instrument close to the eye of the patient, into which he reflects light in the usual manner. A foreign body in the cornea, a macula, a deposit on the posterior surface of the cornea, or an opacity in the lens appears as a dark spot against the red background. Small vitreous opacities appear dark; larger ones, often in the form of webs, strings, and clusters, may have a grayish appearance. In extensive hemorrhage into the vitreous a reddish tint may sometimes be detected, although usually it is quite dark and there is no red reflex from the fundus.

While making these examinations, the surgeon, keeping the instrument steadily in place, should require the patient to move his eye in various directions. Freely moving opacities are almost certainly in the vitreous. If the opacity retains its position unchanged, it lies in the pupillary plane, upon or immediately below the capsule of the lens. If the opacity apparently moves in the same direction as the moving eye, it is behind this plane, for example, in the deeper portion of the lens or in the vitreous. If the opacity apparently moves in a direction opposite to the moving eye, it is in front of the plane, for instance, in the cornea.

A *detached retina*, examined by this method, appears as a gray or bluish-gray membrane passing forward into the vitreous, containing

folds which give rise to a sheen. If the substance beneath the detached retina is fluid, as in simple detachment, it oscillates with the movements of the eye; if it is solid, as, for example, a tumor, usually neither folds nor tremulousness are present. In the latter circumstances, the eye having been cocainized and the pupil dilated, the glowing bulb of the electric ophthalmoscope, or a specially designed instrument called a transilluminator, should be passed over all areas of the exposed sclera. In the absence of a growth, the red glare coming through the pupil remains undisturbed; in the presence of a growth, the pupil becomes dark when the light passes over that area of the sclera which lies directly above the tumor.

In order to facilitate these types of opthalmoscopic examination, the pupil should be dilated, if there are no signs of glaucoma present (see p. 81), with a drop of homatropin solution, 8 grains (0.52 gm.) to the ounce (30 c. c.), or with a drop of 10 per cent solution of euphthalmin. After the examination is completed a drop of pilocarpin solution, 2 grains (0.13 gm.) to the ounce (30 c. c.), should be instilled to neutralize the effect of the mydriatic.

CHAPTER II.

DISEASES OF THE LID.

Edema of the lid.—This may be *acute*, as after the stings of insects, and often *inflammatory*, as it occurs in styes, acute inflammation of the lachrymal sac, severe conjunctivitis, corneal ulcers, iritis, iridocyclitis, acute glaucoma, and infections of the globe. It is a significant symptom in diseases of the sinuses, especially of the ethmoid and antrum, and is a conspicuous feature in thrombosis of the cavernous sinus and orbital disease. Certain noninflammatory edemas of the lid are important, especially those which occur with cardiac and renal disease, as part of the symptomatology of migrain, as a manifestation of angioneurotic edema, which is fugitive and recurrent, and as an indication of arthritic and gouty tendencies, and rarely in syphilis. Traumatic edema, usually the result of blows, may or may not be associated with a collection of blood in the loose connective tissue—*ecchymosis of the lids* ("black eye")—which is also seen as a symptom of fracture of the skull. Should air escape into the cellular tissue, as may be the case in fracture of the orbit, through a communication thus produced with the ethmoid or frontal sinus, the swelling crackles to the touch and is increased if the patient blows his nose and forces air through the fissured bone (*emphysema of the lid*).

Treatment.—Associated edemas subside with the disappearance of the ocular or general disease which caused them, and require no treatment. Ordinary edemas may be relieved by cold compresses, by applications of lead water and laudanum, or diluted white extract of hamamelis (Pond's extract). Occasionally a light pressure bandage is of advantage. If blood has accumulated in the lid it will gradually absorb, and this absorption may be hastened by hot compresses. The not uncommon practice of applying leeches, or of incising the swollen tissue and sucking out the blood, is a pernicious one. In a number of instances in the last-named circumstances syphilis has been communicated to the patient.

Hordeolum or stye consists of a localized suppurating inflammation of the connective tissue in the margin of the lid or of one of the glands of the follicles of the cilia (Zeiss's glands), and is almost always due to staphylococcus infection. This may remain a tender, circumscribed swelling, which becomes invested with a yellow cap, indicating sup-

puration, or it may cause considerable pain, with edematous swelling of the entire lid and chemosis of the conjunctiva. Some persons are subject to a mild type of styes which appear in the form of superficial pustules along the margin of the lid. A characteristic feature of hordeolum is its tendency to recur, and a single stye, or several at a time, may appear again and again for many weeks. Recurring hordeola may be the starting points of a chronic blepharitis. Driving in the cold or dust and the strain of uncorrected ametropia predispose to this disorder. Frequent "attacks" of styes indicate derangement of health, and are especially associated with constipation and menstrual irregularities.

Treatment.—Suppuration should be encouraged by repeated applications of small compresses steeped in hot water, and on the earliest appearance of pus a deep incision should be made through the base of the swelling, parallel to the edge of the lid. In persistent and recurring formation of styes treatment with bacterial vaccines controlled by determining the opsonic index has achieved excellent results.

Abscess of the lid appears as a localized red elevation, and is often a severe form of furuncle or hordeolum. The entire lid is hyperemic and the conjunctiva injected and often edematous. There is much pain, headache, and fever. This affection is provoked by injury, exposure, and disease of the orbit, and sometimes arises without ascertainable cause, especially in debilitated people and children. In rare instances it has been followed by thrombosis of the orbital veins and cavernous sinus and has terminated fatally.

Furuncle of the lid is a localized inflammation of the skin and subcutaneous tissue, presenting symptoms analogous to abscess, which goes on to the formation of a central slough or "core." The surrounding and overlying tissue may become gangrenous in subjects of poor nutrition.

Treatment.—Pointing should be favored by hot, slightly carbolized fomentations or compresses soaked in boric acid solution. As soon as fluctuation is detected, or even earlier, a sharp knife may be thrust through the swelling, parallel to the muscle-fibers, and the contents evacuated; the cavity is to be kept clean with an antiseptic fluid.

Herpes facialis of the lids.—Occasionally one or several groups of herpes vesicles develop upon the eyelids. The lesions usually appear in the form of a small cluster or a coalescent patch. The lid is swollen, reddened, and the disease gives rise to a burning and itching sensation. The lower lid is affected more commonly than the upper.

Treatment.—The best application is ichthyol ointment, and under its influence the lesions rapidly disappear. The associated conjunctivitis should be treated with the usual applications—boric acid and argyrol.

Herpes Zoster ophthalmicus.—In this infectious exanthem an eruption of vesicles takes place over the region of the supraorbital and sometimes of the nasal nerve. Severe neuralgia precedes the appearance of the vesicles, which may develop in crops, or coalesce into irregular patches, and are distributed over half of the forehead and often far back in the scalp. If the nasal branch is affected the eye usually is seriously involved and corneal ulcer, iritis, and iridocyclitis may develop. So violent is the disease at times that it may be mistaken for erysipelas. For the ocular conditions the local treatment is that suited to iridocyclitis (p. 65) and corneal ulcers (p. 55). Internally salicylate of sodium and aspirin are useful, and the herpetic lesions may be dusted with rice powder, or dressed with boric acid ointment, or with ichthyol ointment, or painted with a 5 per cent solution of iodin.

Blepharitis is a term applied to various subacute and chronic inflammations of the lid margins and may manifest itself in a *non-ulcerated* and *ulcerated* variety.

In blepharitis without ulceration, often called *squamous blepharitis*, the abnormal secretion of the sebaceous glands causes a greater or less accumulation of yellowish-white scales clinging to the base of the eyelashes, which readily fall out, but are reproduced because the cilia follicles are not destroyed. The lid margins are slightly swollen and hyperemic.

In blepharitis with ulceration, really a special localization of *eczema of the lid border*, the ciliary margins are decidedly swollen and red, crusts form, and the lashes, often stunted and deformed, are matted together. On removal of the crusts slightly pitted ulcers are seen, which easily bleed. In this variety the hair follicles are destroyed and the lashes are rarely reproduced. Common sequels are misplaced ciliæ (trichiasis), loss of eyelashes (tylosis), chronic hypertrophy of the lid margin, the so-called lippitudo or "blear-eye," and chronic conjunctivitis.

Causes.—Blepharitis is often caused by uncorrected refractive error. It is aggravated and excited by exposure to wind, dust, and heat, and by intemperate habits. Staphylococci are found in the pustules, and not infrequently the Morax Axenfeld bacillus. The malady may follow in the wake of the exanthemata, especially measles, and the severe varieties are common, especially in young subjects and children who are anemic or who have a tuberculous habit, and may be associated with lachrymal disease and various types of nasal catarrh.

Treatment.—All scales and crusts must be removed by rubbing the lids with an alkaline solution, bicarbonate or biborate of soda (gr. viii–f3i (0.52 gm.–30 c. c.), or with a 5 per cent solution of chloral. If the crusts are thick, or in the ulcerated varieties, they

and the distorted lashes may be removed with epilating forceps. In all varieties a daily scrubbing of the lid margins with the lather of a good neutral soap is of excellent service. Following the removal of the crusts and scales the ciliary border should be massaged with a salve of the yellow oxid of mercury (gr. i–3i (0.065–3.885 gm.). The ulcer may be penciled with a 2 per cent solution of nitrate of silver, and if the Morax Axenfeld bacillus is present, with a 1 per cent solution of sulphate of zinc. Expression of the pathologic secretion from the lid margins is often of value, and excellent additional ointments are ichthyol (2 to 5 per cent of the ammoniacal salt), boric acid ointment, and aristol ointment. The conjunctival sac should be frequently douched with a saturated boric acid lotion, and the lachrymal passages should be kept patulous, and any associated nasal disease should receive appropriate treatment, even the use of Dobell's solution through an atomizer being of service.

Tumors and cysts of the eyelids.—A variety of growths, cystic and solid, are found upon the eyelid and its border. *Warts* or *papillomas* are common. As they may eventuate, especially in elderly persons, in epitheliomas, they should be removed, or still better, they should have applied to them radium, which causes them to disappear with satisfactory rapidity.

Epithelioma of the lid may require removal, and if it is extensive plastic operations, but in the earlier stages, and in some instances when the growth has become extensive, excellent results are achieved by the use of the X ray. In most circumstances, however, radium is preferable and more certain, as this agent can usually be employed to better advantage and with greater safety to the eye.

Chalazion—(Meibomian cyst; tarsal tumor).—This is a small tumor due to a chronic inflammation of a Meibomian gland and the tissue which surrounds it. The growth begins by retention of the secretion of the Meibomian gland, followed by a peri-adenitis and destruction of the tarsal cartilage, with passage of the tumor toward the conjunctiva (*internal chalazion*) or to the skin (*external chalazion*). A chalazion may form in the excretory duct of a Meibomian gland, and then projects in a nipplelike body from the edge of the lid. Chalazia may be single or multiple, and in severe cases recurrences may be frequent until a chronic infection of the Meibomian glands and alteration of the tarsal cartilages take place.

Symptoms.—The tumor grows slowly, unless it is of the acute type, and forms a firm swelling attached to the tarsus. The skin usually is freely movable over it; on the conjunctival surface a discolored patch marks its position. Suppuration may take place in the growth.

A so-called acute chalazion may be mistaken for an external stye, from which it is to be distinguished by the more circumscribed charac-

ter of the inflammation, and by the fact that the stye points in the edge of the lid; and a chronic chalazion for a sebaceous cyst from which it may be differentiated by the firmness of its attachment to the tarsus.

Treatment.—A chalazion can be readily removed by everting the lid when a discolored patch marking its position is made prominent. This is incised and the contents scraped out with a curette. The cavity fills with blood, the absorption of which may be hastened by the use of hot compresses. If the chalazion is a large one and dense in structure and is prominent toward the skin surface, it is better to remove it through an incision made in the integument, the lid being steadied in a clamp, and the cyst dissected from its bed in the ordinary manner. One or two stitches close the cutaneous incision.

Trichiasis.—This is an affection in which the lashes are misplaced and turn inward against the eyeball in such a manner that they rub the cornea, and often produce intense irritation, even at times ulceration of this membrane.

Trichiasis is usually caused by chronic inflammations of the lid border, for example, blepharitis, and by trachoma. If only a few lashes have a faulty direction, they may be removed with cilium forceps, and should they grow again the procedure may be repeated. Occasionally good results are obtained by destroying the hair follicles by galvano puncture. Long-standing trichiasis in association with entropion can usually only be managed satisfactorily by means of various operative procedures, whereby the entire ciliary border is turned or transplanted from its faulty position.

Entropion, or inversion of the lid, like trichiasis, is most commonly caused in its organic forms by trachoma and by some of the other severer forms of conjunctival inflammation. Naturally entropion and trichiasis are usually associated conditons, and require for their cure the operations to which reference has been made.

There is also a *spasmodic* variety of entropion which may occur under the influence of conjunctivitis, keratitis, foreign bodies in the eye, prolonged bandaging, and which will subside if the exciting cause can be removed. A most excellent plan, however, to afford temporary relief is to evert the lower lid and hold it in place with a longitudinal strip of plaster, which is fastened to the cheek. Many of these forms of spasmodic entropion, especially as they occur in elderly persons, often in association with a chronic conjunctivitis, can be permanently relieved by pinching up with entropion forceps a strip of skin parallel to the ciliary border. This strip, together with the subjacent fibers of the orbicularis muscle, is excised. The wound is closed with silk sutures, and dressed in the ordinary way.

Ectropion, or eversion of the lid, with exposure of the mucous surface, is more frequently an affection of the lower than of the upper lid.

Just as spasmodic entropion can occur, there is a type of *acute ectropion* seen in conjunctival diseases, which disappears when the inflammation subsides.

The chronic form is frequently the result of an injury, either of the lid itself or of the adjacent surface of the cheek, for example, a laceration, followed by a contracting scar, and is frequent after burns and the subsequent cicatricial changes. It is an exceedingly common affection, as the result of inflammatory conditions of the ciliary margin, for example, in chronic blepharitis, and occurs often in elderly persons, the everted conjunctiva being thickened, roughened, and lacking in moisture.

A slight ectropion, especially of the inner end of the lid in the neighborhood of the punctum, may sometimes be remarkably relieved by dilating the canaliculus and probing the nasal duct. In well-produced organic ectropion a plastic operation for its relief is almost always necessary, particularly if the lid is pinned down and everted by contracting cicatrices after burns, wounds, and periostitis of the malar bone. In these plastic procedures the vicious cicatrix is embraced in the incision and the gap filled by transplanting a flap of skin from the forehead, temple, or cheek. Numerous operations have been devised, and the site and character of the lesion must in each instance determine the best method of procedure. Quite good results in some forms of ectropion are secured by galvano-cautery puncture, the point of the cautery being pushed through the cartilage and quickly withdrawn. The punctures are made 4 mm. from the lid margin and separated from each other by an interval of 4 mm. The same procedure is applicable to certain types of entropion, when naturally the puncture must be made on the skin surface.

CHAPTER III.

DISEASES OF THE LACHRYMAL APPARATUS.

Epiphora and its significance.—Closure of the lachrymal puncta, of the canaliculi, or obstruction of the lachrymo-nasal duct, always causes epiphora, or an overflow of tears. It is a common symptom in chronic inflammations of the lid and conjunctiva, because in these circumstances the swollen and inflamed conjunctiva is responsible for closure either of the punctum or the canaliculus. But epiphora, although always a sign of lachrymal obstruction, is not necessarily caused by it. Thus, it is an early symptom of palsy of the facial nerve, it is common in various types of refractive error and especially in insufficiency of the internal recti muscles, and sometimes appears in excessive degree, even before exophthalmos is manifest, in Graves's disease. Elderly persons are often much afflicted with an overflow of tears, even when there is not much obstruction of the lachrymo-nasal duct, particularly evident in cold and windy weather, and often associated with swollen and vaso-paretic turbinate bodies, and in every case of epiphora careful examination of the nasal passages should be made, in order to determine whether they and not the duct are at fault.

In treating this type of epiphora dilatation of the canaliculus, then irrigating it and the lachrymo-nasal duct by means of the fine point of an Anel syringe charged with a slightly astringent lotion, for example, boric acid, is often of advantage if the nasal chambers at the same time receive appropriate treatment. Occasionally the so-called senile epiphora is much relieved by frequent irrigation of the conjunctival sac with a solution which contains 16 grains (0.104 gm.) of biborate of soda, 15 minims of adrenalin (1–1,000), and 4 ounces (120 c. c.) of distilled water. A lotion composed of 2 grains (0.13 gm.) of sulphate of zinc, a few drops of adrenalin, and 2 ounces of distilled water is also valuable.

Acute dacryocystitis.—Acute inflammation of the lachrymal sac may be preceded by fever and chill, the lids and regions of the nose become tense and tender to the touch, and a red and brawny swelling resembling erysipelas, for which it has often been mistaken, overspreads the skin in the region of the sac. The inflammation may

involve the cellular tissue and the pus burrow in front of the sac and form pouches in the connective tissue. Usually a *lachrymal abscess* such as this, points just below the tendo oculi. It may rupture spontaneously, and a fistulous opening surrounded by pouting granulations may form.

Treatment.—Usually the pain and swelling are so great that it is necessary to make an opening upon the face about 1 cm. below the palpebral tendon, cutting downward and slightly outward. The cavity should then be curetted and packed with gauze and allowed to heal from the bottom. Relief may also be afforded by hot compresses of carbolized water at a temperature of 120° F., which are frequently changed and applied for five minutes at a time. Later, when the swelling subsides, either with or without previous slitting of the canaliculus, probes may be passed and the passage into the nose rendered patulous.

Chronic dacryocystitis.—Usually there is a moderate distention over the region of the lachrymal sac, and pressure upon it expresses through the puncta the retained fluid. Depending upon the character of the inflammation and its state, this fluid is semitransparent, viscid, mucous, or turbid, because purulent material is mixed with it. These chronic types of dacryocystitis may at any time develop an acute inflammation with all the symptoms that have just been described.

Obstruction or stricture of the nasal duct.—Usually this antedates the inflammations of the sac which have been described. The obstruction may be situated in any portion of the lachrymo-nasal duct, but generally is found at that point where the nasal duct enters into the sac, or the lower end, where it passes into the nasal chamber. Epiphora is always markedly present, the "eye swims in tears," and these are excited to overflow by exposure to dust, cold, and wind. In nearly every case of disease of the lachrymal sac and of the lachrymo-nasal duct the nasal chambers are abnormal, and examination will reveal tumefaction of the mucous membrane, hypertrophy and abnormal position of the turbinate bones, and not infrequently there may be ethmoiditis and purulent disease of the antrum of Highmore.

Treatment.—It is usually recommended that in stricture of the lachrymo-nasal duct the canaliculus shall be slit, as follows: The lid is drawn down and out with the thumb, and the probe point of a canaliculus knife held vertically, is introduced into the punctum. The handle is next depressed in the horizontal position, and the instrument pushed along the canal until the probe point touches the inner wall of the sac. It is then raised to the vertical line, with the cutting blade turned slightly inward and the roof of the canaliculus divided. Following this, the lachrymal probe is introduced by passing it horizontally along the canaliculus until its point touches the lachrymal bone. It is raised to the vertical position, pushed

gently into the duct, remembering that the direction should be downward, slightly backward, and outward. It is essential that no force shall be used lest a false passage should be made by breaking through the delicate wall of the lachrymal bone. If the passage of the probe is successful, it may be repeated daily, gradually increasing the size of the probe and thus dilating the stricture. Following the probing the canal should be irrigated by means of an Anel syringe with some antiseptic fluid. This is particularly necessary if, in association with the stricture, there is chronic inflammation of the lachrymal sac and accumulation of pus and muco-pus. It is a common practice to use argyrol in these circumstances—25 per cent—and it has a distinct value in that it is very penetrating and detergent and brings the pus, which has accumulated in the delicate folds of the tissue, to the surface. Great care must be used, however, that it shall not escape into the surrounding structures, where it may readily cause unsightly staining of the skin. Irrigating fluids may be composed of boric acid, bichlorid of mercury, 1–5,000, or permanganate of potassium, 1–5,000, and sulphate of zinc, one-half of 1 per cent. Pathologic conditions in the nose must be carefully corrected.

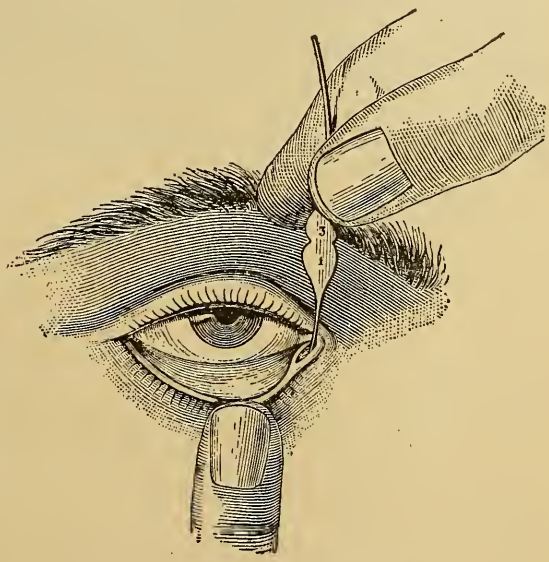

Fig. 5.—Introduction of a lachrymal probe.

A more satisfactory way of treating chronic dacryocystitis consists in extirpation of the lachrymal sac, which is indicated if conservative measures, or the procedures just described, have failed to cure the condition, if the patient can not devote sufficient time to treatment, if there is an impassable stricture, if operation on the eye is indicated, and for the relief of infected ulcers of the cornea which may be an associated condition.

The fluid in a chronically inflamed lachrymal sac is highly charged with pathogenic microorganisms. The streptococcus pyogenes and pneumococcus, as well as other organisms, are always present in virulent strains, and if the cornea should be abraded in these circumstances, such an abrasion may rapidly be converted into a sloughing

ulcer. Under such conditions also operations on the eyeball, for example, a cataract extraction, or an iridectomy, would be absolutely contraindicated until the lachrymal disease had been cured.

Dacryoadenitis.—Although inflammation of the lachrymal gland is not a common affection, it occurs with sufficient frequency to deserve mention, and may appear in an acute or in a chronic form. Rarely there is suppuration. It may be caused by acute infectious diseases, notably influenza, and sometimes becomes enlarged during attacks of mumps. One variety of this affection is tuberculous in nature, and enlargement, both of the lachrymal sac and of the palpebral portion of the gland is occasionally observed in association with diseases of the conjunctiva and cornea. The chronically inflamed gland can usually be felt by palpating with the finger beneath the outer border of the orbit. In acute cases hot applications are of service, and should suppuration occur, an incision may be made either through the integument parallel to the eyebrow, or through the conjunctiva.

CHAPTER IV.

DISEASES OF THE CONJUNCTIVA.

Acute conjunctivitis (simple or catarrhal conjunctivitis).—In this affection there are congestion of the posterior conjunctival vessels, loss of transparency and slight tumefaction of the palpebral conjunctiva, some dread of light, slight edema of the lid margins, and an abnormal secretion, at first watery, but speedily changing to a mucopurulent character. In the discharge are found *staphylococcus aureus* and *albus*, occasionally mild strains of *pneumococcus*, and sometimes, in one variety, the *micrococcus catarrhalis*. It may arise independently, especially in changeable weather, and may be associated with systemic conditions, with nasal catarrh, with the exanthemata, and may be excited by wind and dust.

In our country, especially on the plains and the southern borders, a form of acute conjunctivitis, due to irritation from alkaline dust and aggravated by the glare from sandy soil, is very common, photophobia and a rather acrid secretion being common features.

The prognosis of these types of conjunctivitis is perfectly good, and the symptoms readily subside in the course of a few days under the influence of boric acid irrigation. The instillation of a 25 per cent solution of argyrol or sulphate of zinc lotion is also useful. The eyes may be protected by smoked glasses, but bandages and poultices must not be used.

A more active manifestation of catarrhal conjunctivitis, which on account of certain characteristic features may be regarded as a distinct affection, is—

Acute contagious conjunctivitis (Koch Weeks bacillus conjunctivitis, "pink eye").—In this affection there are marked edema of the lids, very free purulent secretion, often gathered into long strings, and small subconjunctival hemorrhages. Typical cases are due to the *Koch Weeks bacillus*, and another variety depends upon the *pneumococcus* (*pneumococcus conjunctivitis*).

Easily and actively communicable, this infection spreads rapidly from one person to another, and where individuals are closely associated, as in schools, camps, barracks, etc., it can speedily develop into an epidemic. The duration of the disease is usually about six days;

practically always both eyes are affected. The prognosis is entirely favorable; only in rare instances small marginal ulcers of the cornea develop.

Treatment.—The treatment should include iced compresses to reduce lid edema, boric acid irrigations, or a lotion of bichloride of mercury (1–10,000); sulphate of zinc (one-half of 1 per cent) is also valuable. Argyrol (25 per cent), freely instilled, is useful, or in severe cases a 1 per cent solution of nitrate of silver, brushed over the everted lids and neutralized with physiologic salt solution, may be tried.

Traumatic conjunctivitis, already referred to as the result of exposure to wind, dust, etc. (alkali conjunctivitis) may occur from the introduction of many chemical and mechanical irritants, e. g., tobacco smoke or dust, plant hairs, or the short hairs from horses, the stings and presence of various insects, etc. The usual collyria, after removal of any foreign substance, are sufficient to cure the affection.

One form of traumatic conjunctivitis has been a serious menace to troops in the present war, viz, that which occurs as the result of "gas attacks." Depending upon the character of the gas employed in these circumstances, the chief symptoms are intense irritation, edema of the lids, and enormous chemosis of the conjunctiva. According to information received from the western front, in some forms the cornea is practically never involved; in others ulceration occurs (see p. 115). In addition to the ordinary lotions, it would seem advisable in these circumstances to try the effect of the instillation of a 2 per cent solution of holocain and liquid albolene. Following a suggestion of Dr. T. B. Holloway each soldier should be provided with a small rubber receptacle filled with liquid albolene for immediate use.

Chronic catarrhal conjunctivitis.—This may be a sequel of an acute and uncured attack of conjunctivitis or a chronic condition depending upon poor hygiene, vitiated atmosphere, nasal disease, strain of ametropia, and in association with lachrymal affections and with blepharitis. A zinc collyrium ($\frac{1}{2}$ per cent) and touching the thickened and reddened conjunctiva with an alum crystal or painting it with tannin and glycerin (grs. xx–xxx-℥i) are useful procedures, if associated with a removal of the cause. A form of chronic, or, more accurately, subacute conjunctivitis, is—

Morax Axenfeld conjunctivitis (angular conjunctivitis).—In this affection, which etiologically unrecognized may last for months or remain permanently chronic, there are hyperemia and moderate grayish-white secretion, which gathers in frothy masses at the reddened and irritated commisural angles (hence *angular conjunctivitis*). Sometimes an acute manifestation arises, with symptoms resembling acute catarrhal conjunctivitis, with swelling of the mucous membrane.

These types of conjunctival disease are due to the Morax Axenfeld bacillus, readily detected in conjunctival smears examined bacteriologically, and these should always be made and sent to the laboratory of the hospital in all cases of conjunctival disease.

The *treatment* of this affection differs from those already described in that agents such as protargol, argyrol, nitrate of silver, etc., are practically without curative effect. The preparations of zinc are, however, practically specific. They may be employed in the form of the sulphate of zinc (0.5 of 1 per cent), or the chlorid (0.2 of 1 per cent), or the sozoiodolate (1 to 2 per cent). Under their influence the affection disappears with astonishing rapidity.

Gonorrheal conjunctivitis.—This may occur in adults, or in newborn children (*gonorrheal ophthalmia neonatorum*).

The adult type of this affection can usually be traced to a communication from an acute gonorrhea or a gleet, by contact with soiled fingers or linen, or from an eye affected with this type of conjunctivitis, and like urethral gonorrhea, is due to the activities of the gonococcus, which is readily detected in the pus after staining smears with the ordinary reagents—for example, methylen blue.

Usually appearing within 24 to 48 hours after inoculation, its symptoms develop with great activity; rapid and tense edema of the lids, thick, greenish-yellow pus, marked chemosis of the bulbar conjunctiva, and unless the violence of the inflammation is quickly subdued, haziness of the cornea, ulceration of this membrane, which may quickly be perforated and prolapse of the iris with all its evil consequences may occur. Loss of the eye from the formation of staphyloma, or sloughing of the entire cornea and phthisis bulbi, is always imminent. The prognosis is exceedingly grave, and fully developed gonorrheal ophthalmia almost always eventuates in corneal ulceration. The right eye is more frequently affected than the left; sometimes both eyes are involved.

Treatment.—The following method of treatment will be found to be valuable: (1) The constant application of iced compresses, which in the earlier stages should be continuous, but as the inflammatory process subsides may be employed for periods of 20 minutes to half an hour every three or four hours. (2) The conjunctival sac should be irrigated with sufficient frequency to wash away the rapidly accumulating pus, using either bichloride of mercury, 1–8,000, or cyanide of mercury, 1–5,000, or a saturated solution of boric acid, or iced physiologic salt solution. (3) Into the conjunctival sac a 25 per cent solution of argyrol should be instilled with sufficient frequency to keep the inflamed mucous membrane immersed in the fluid. The argyrol has absolutely no germicidal effect, but it is detergent, sinks to the bottom of the cul-de-sac, and floats to the surface pus and mucous, which can thus be readily removed. In place of argyrol,

protargol may be employed in 10 per cent solution. (4) In addition to the argyrol immersion treatment, once a day the lid should be everted and painted with a 2 per cent solution of nitrate of silver, the excess to be neutralized with physiologic salt solution until the white film which accumulates after the silver application, has been thoroughly washed away. The lids are then returned to place and annointed with vaseline, some of which is permitted to enter the sac. In place of the nitrate of silver application, a similar one with a 50 per cent solution of argyrol has been advised. (5) The cornea must be watched with great care for signs of haziness or ulceration, and practically always it is necessary to keep the iris under the influence of a mydriatic, for example, a drop of a 1 per cent solution of sulphate of atropin, two or three times a day.

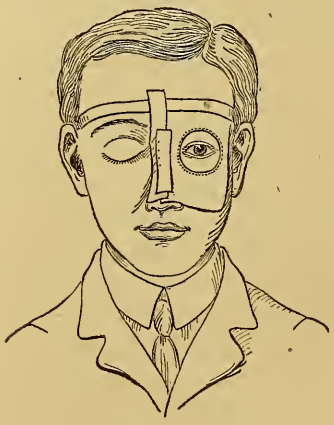

FIG. 6.—Application of Buller's shield.

If there is great brawny chemosis of the bulbar conjunctiva, and, therefore, great danger of corneal sloughing, incisions of this hard rim relieve the pressure. Occasionally in stubborn cases Kalt's method of using copiously, a pint at a time in continuous irrigation, a solution of permanganate of potassium, 1–2,000 to 1–5,000, once a day, acts most favorably. Naturally, the vigor of these applications must be lessened as the inflammatory symptoms subside. The spread of a corneal ulcer may sometimes be checked by applying to it trichloracetic acid, or liquid carbolic acid, care being taken to touch only the sloughing area. If one eye alone is affected, the other eye should be carefully protected by covering it with a Buller's shield, made from a watch crystal, carefully put in place with strips of plaster, or gauze and collodion. Much of the success of the treatment of this disease consists in constant attention, and a special nurse or a skilled orderly should be detailed for this purpose. Great care must be taken to destroy all cotton, cloths, etc., which come in contact with the inflamed eye. The patient should be isolated, and have his own set of treatment bottles, etc.

The infantile variety of this affection is usually denominated—

Ophthalmia neonatorum (conjunctivitis neonatorum).—This disease is usually due to the introduction into the eye of infecting material from some portion of the genito-urinary tract of the mother. In about 60 to 70 per cent of the cases the active microorganism is the gonococcus of Neisser.

The inflammation usually begins on the third day after birth, sometimes as early as from 12 to 24 hours after inoculation.

Generally beginning with trifling redness of the eye and discharge from the conjunctiva, the symptoms rapidly develop, as in the adult type of this disease: swollen lids, thick, greenish-yellow pus, chemosis of the conjunctiva, and always the danger of corneal ulcers and their complications (compare p. 54).

The prognosis is much more favorable, although also grave, than that of gonorrheal ophthalmia of adults, and if the eye is seen while the cornea is still bright, proper treatment should, with comparatively few exceptions, result in perfect cure. In infants of depraved nutrition, and in some apparently malignant types, all treatment seems to be unavailing.

Treatment.—This, with certain exceptions, should conform to that which has been described on page 41. The exceptions are: Iced compresses must be always used cautiously, and often not at all in babies who are not robust; such procedures as Kalt's method, incision of the chemotic conjunctival rim are not advisable; atropin drops, if at all employed, should be reduced in strength to 1/5 of 1 per cent. The disease is practically always bilateral.

The *prophylaxis* consists in the employment of Crédé's method, i. e.: As soon as the head is born, parting the lids, previously wiped clean, and instilling 2 drops of a solution of 1 or 2 per cent of nitrate of silver, if previous examination of the mother has revealed danger of infection, or if such examination has not been possible.

The cases of ophthalmia neonatorum which are not gonorrheal in character, and these can always be detected by bacteriological examination, require the same treatment as that recommended for ordinary acute conjunctivitis.

Trachoma (granular conjunctivitis, "granulated lids").—This affection depends upon a chronic inflammatory infiltration and hypertrophy of the conjunctiva, and this lymphoid infiltration attacks the tarsus, as well as the conjunctiva, and sometimes manifests itself in a diffuse form, and sometimes by circumscribed collections of cells, which are known as "follicles," or trachoma bodies.

Microscopic examination of the follicles reveals lymphocytes, mononuclear leucocytes, phagocytes, and certain accessory cellular elements, e. g. multinuclear cells. Leucocytes infiltrate the lymphadenoid tissue which surrounds the follicles. This morbid process leads to destruction of the conjunctiva, and to the development of scar tissue.

Symptoms of clinical varieties of trachoma.—*Acute trachoma*, although described, is really not a separate form of the disease, but an admixture of ordinary "granulated" lids and acute conjunctival catarrh, or represents an exacerbation of a chronic affection.

Chronic trachoma is conveniently divided into three varieties: (*a*) *Papillary trachoma*, which is characterized by an infiltration of the

adenoid layer, which pushes up the thickened epithelium and hypertrophied and congested conjunctival papillæ. The appearances are not unlike those of aggravated chronic conjunctivitis, and the thickening and redness of the tissue may be so great that it somewhat resembles raw beef, and sometimes has been compared to the surface of a raspberry. Often it is difficult to detect the follicles or trachoma bodies, which are hidden in the swollen tissue. Vascularity increases, fresh follicles are produced, and others undergo softening and absorption. Photophobia may now be present, mucopurulent or purulent discharge develops, and corneal changes (pannus and ulcers) may arise.

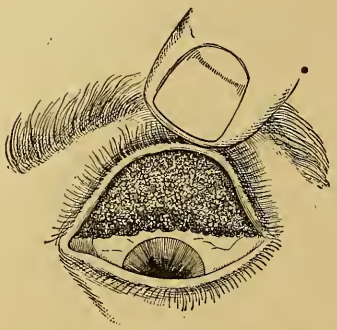

Fig. 7.—Follicular trachoma.

(*b*) *Follicular trachoma* is characterized by a decided development of grayish-white or yellowish-red follicles in the fornices, often in rows along the upper margin of the superior tarsus. They may also invade the ocular conjunctiva, and even the caruncle and plica. They have been called "sago-grain" or "vesicular" granulations, and have been likened to the appearance of frog-spawn. It is important to remember that the lesions develop especially in the upper retrotarsal folds, without antecedent inflammation, and so insidiously that their real nature is for a long time unknown to the patient and can not be detected unless the lids are everted. At this period there may be little or no secretion, but later follicular and cellular masses compress the conjunctiva, and the increased secretion, heaviness of the lids, and corneal changes already noted are present.

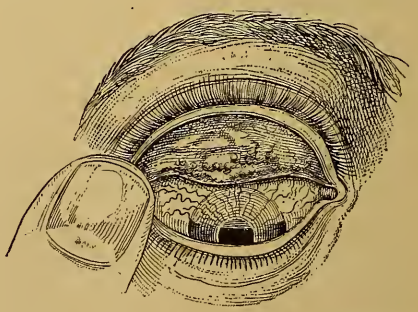

Fig. 8.—Typical granular lid and beginning cicatrization, with pannus.

(*c*) *Cicatricial trachoma* represents the late stage, and is characterized by the formation of gray-white scar lines. They often intersect remains of old granulations. There is not much secretion in this stage, unless an exacerbation occurs, and often the conjunctiva is very dry.

During the course of trachoma certain complications develop, the most conspicuous being (*a*) *Acute exacerbations*, or *superadded infections*, to which reference has been made. When they are conspicuous the irritative phenomena are intense, with scalding tears, great dread of light, corneal involvement, and purulent discharge;

(*b*) *Pannus*, which is a form of vascular keratitis, and while the rough upper lid is a predisposing factor, the condition really represents a form of direct infection. Usually the condition is first manifest in the upper half of the cornea, and vessels proceed inward from the corneal loops, and at first lie between the epithelium and Bowman's membrane. In severe cases this tissue may break down and the deeper corneal layers may be involved. (*c*) *Ulcers of the cornea*, which may be deep and sloughing, may perforate the cornea, and may leave dense scars and give rise to staphyloma, or which may be shallow and be centrally placed, with a turbid base, at or near the apex of the pannus. (*d*) *Trichiasis*, *entropion*, and *ectropion*, which have been described (page 33). (*e*) *Xerosis of the conjunctiva*, the membrane undergoing, as the result of induration, a form of drying up. Lachrymal obstruction, dacryocystitis, and obliteration of the punctum and canaliculus are frequently present in old trachomatous subjects.

Cause and prevalence of trachoma.—There is no proof that microorganisms of the bacterial group, or blastomycetes, cause trachoma. The detection in the discharge and in the follicle contents of granular conjunctivitis of the so-called Prowazek corpuscles, or bodies, is significant, because they are rarely found in other conjunctival diseases, but their absence does not exclude trachoma. In short, the cause is unknown. Persons in poor health and who are anemic and dwell in unhygienic surroundings, and who are crowded together, often acquire trachoma, but it does not depend upon any constitutional disorder, and may attack those who are in perfect health.

Trachoma is widely spread throughout the world. It is most frequent in Arabia and Palestine, and in Egypt it is generalized and frequently exhibits a mixed infection, hence the term *Egyptian ophthalmia*. It is exceedingly prevalent in Eastern Europe, especially in Gallipoli, Poland, Russia, Hungary, and certain districts in Prussia. Jews of inferior social grades are prone to be affected, as are Italians of the lower order, especially in the south of Italy. In England it is an alien disease; in Ireland it is common among the poorer classes. The menace of trachoma on our own shores is one of the serious problems of our immigration officers. It is common among native Americans, especially in definite areas in Illinois, in the mountains of Kentucky and West Virginia, and in general terms in the Appalachian region. Trachoma is of frequent occurrence in Oklahoma, Arkansas, Texas, Arizona, and New Mexico. About 30 per cent of our Indian population is affected. To a certain extent negroes resist trachoma, but they are not immune.

During those stages of the disease in which there is mucopurulent discharge the spread of the infection is greatly stimulated, especially where people dwell in uncleanly surroundings, and carelessly

use common towels, utensils, and bed linen, and in armies, barracks, camps, asylums, etc., may develop into a serious epidemic. It is always a contact infection, and can not be communicated through the medium of the air.

Prognosis.—Trachoma, always a serious disease, may last for months and years, if neglected, and cause greatly defective vision and often practical or total blindness. If properly managed, however, the disease is curable, and every effort should be made to bring its subjects under early treatment and to keep them from coming in contact with those who are unaffected. Its introduction into armies has almost always come from the surrounding civil population, hence the importance of inspecting not only recruits and soldiers but also all those who come in their close environment.

Diagnosis.—Trachoma well and typically developed offers no difficulties in the way of diagnosis, but this must rest, as far as present knowledge goes, upon clinical examination. While *chronic conjunctivitis*, with hypertrophy of the mucous membrane, bears some resemblance to trachoma it is distinguished from it by the greater hypertrophy and by the thickening and induration of the tarsus in the latter disease. *Vernal conjunctivitis* may suggest trachoma, and the two diseases have often been confounded. The former, however, occurring commonly at special seasons, during warm weather, is characterized by flattened granulations, covered with a film, as if brushed over with a thin layer of milk, and in the secretion, which is abundant and stringy, eosinophiles are conspicuously present; also there is the absence of infiltration and of pannus.

The chief difficulty arises in endeavoring to distinguish *folliculosis of the conjunctiva*, or *follicular conjunctivitis*, from follicular trachoma; indeed, some authors do not make a distinction. Confessedly there are many border-line cases, and yet there is a distinct difference between the two affections. Follicular conjunctivitis is characterized by small pinkish prominences in the retrotarsal fold, usually arranged in parallel rows, which are smaller by more than one-half than trachoma follicles, which are largely confined to the fornices, which never develop in the bulbar conjunctiva, and which disappear without leaving any scar tissue or causing any signs of pannus; in these respects, therefore, differing widely from the follicles of trachoma.

Treatment.—As medicamental measures to check infective secretion the usual antiseptic and slightly astringent lotions may be employed. Those which serve the best purpose are saturated solutions of boric acid, equal parts of boric acid and physiologic salt solution, bichlorid of mercury (1–5,000, 1–10,000), and cyanid of mercury (1–1,500). The irrigations should be liberal, preferably with warmed solutions, and frequently repeated. To control the purulent quality

of the secretion, a solution of nitrate of silver (2 per cent) painted over the diseased conjunctiva after thorough eversion of the lid and neutralized after the white film forms, by irrigations with physiologic salt solution, is strongly indicated. For the same purpose argyrol (25 per cent) and protargol (10 per cent) are much employed. None of the silver preparations should be used for long periods of time lest argyrosis of the conjunctiva be produced, and on this account these preparations, especially argyrol and protargol, silvol, and the like should not be given to the patient for home use.

Abnormal secretion being in control, a smooth crystal of sulphate of copper is applied to all portions of the affected palpebral conjunctiva, and the surface after a few minutes flushed with cold sterile water. An excellent application is a 5 per cent solution of this remedy in glycerin, applied with a cotton mop, the patient several times a day instilling into the conjunctival cul-de-sac a 1 per cent solution of the same preparation. To hasten the absorption of the follicles and to prevent xerosis of the conjunctiva applications of boroglycerid (30–50 per cent) are useful, as is also tannin and glycerin, 30 to 60 grains to the ounce (1.95–3.9 gm. to 30 c. c.). During acute exacerbations of trachoma, so-called acute trachoma, in addition to the usual collyria, if there is iritic involvement, mydriasis is indicated. This may be secured with atropin sulphate, 4 grains (0.26 gm.) to the ounce (30 c. c.), or preferably with scopolamin hydrobromate, 2 grains (0.13 gm.) to the ounce (30 c. c.) of distilled water. A corneal ulcer, if infected, should be cauterized with trichloracetic acid or carbolic acid, and in these circumstances holocain (2 per cent) and dionin (5 per cent) are of value.

Mechanical measures.—Massage, associated with medicaments, is often efficacious. After instilling one drop of adrenalin solution (1–2,000), a tightly wound cotton mop, dipped in a solution of bichlorid of mercury (1–300 or 1–500) is, after eversion of the lid, rubbed firmly over the affected conjunctiva for two minutes, the cotton being kept moist with renewed applications of the sublimate solution. Next, the conjunctival surface is thoroughly irrigated with a hot boric acid solution, followed by a drop of a 4 per cent solution of cocain. This procedure should be repeated at two-day intervals, and on the alternate days the same type of massage is employed, save only that for the bichlorid solution, argyrol (50 per cent) is substituted. In place of the bichlorid mixture a solution of cyanid of mercury (1–500) may be used.

Expression.—This procedure is usually performed, according to the method of the late Dr. H. Knapp, and is often known as Knapp's operation: After the patient is etherized, or a submucous injection of cocain is made, the upper lid is everted, seized at the convex border of the tarsus with a pair of fixation forceps, and drawn away

from the eye so as to expose thoroughly the whole palpebrobulbar conjunctiva. If the tissue is infiltrated it may be superficially scarified, preferably with a three-bladed scarifier.

One blade of the roller forceps is pushed deeply between the ocular and palpebral conjunctiva and the other is applied to the everted surface of the tarsus. The forceps is compressed with some force, drawn forward, and the infiltrated soft substance squeezed out as the cylinders roll over the surfaces of the fold held between it. This maneuver is repeated until all the morbid material has been expressed. The lower lid is treated in the same way. During the operation the surfaces should be frequently flooded with a tepid solution of bichlorid of mercury, 1–8, and after the operation cold compresses may be laid on the lid for 24 hours. The following day the lids should be everted, and usually a delicate grayish layer of lymph will be found covering the entire area of operation. This should be removed, the swollen mucous membrane exposed, and touched in the ordinary way with a solution of nitrate of silver, 5 to 10 grains (0.324–0.650 gm.) to the ounce (30 c. c.). Each day this treatment should be repeated until the swelling has subsided, when the daily application of a crystal of sulphate of copper is advisable.

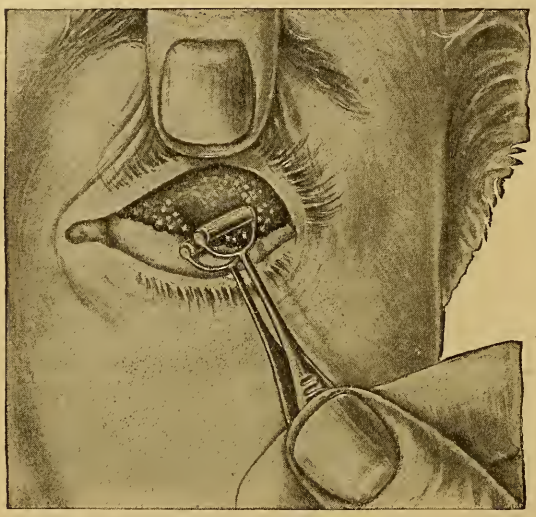

FIG. 9.—Knapp's operation for trachoma.

This operation is especially valuable in cases of spawn-like granulations (*follicular trachoma*), and diffuse hyalin infiltration, and may be used in cicatricial trachoma associated with patches of hyalin degeneration. It is contraindicated during an acute process, or if there is much purulent discharge. Its effectiveness is increased if after the expression a germicide, e. g. bichlorid of mercury (1–2,000) is brushed into the tissues.

In place of the Knapp roller forceps, the Noyes or Prince forceps may be used, or the expressor of Kuhnt, made of two coacting perforated metal plates, which has the advantage that it causes less traction on conjunctival membrane.

Many additional operations for the relief of trachoma have been designed, some of which, for example, excision of the retrotarsal

fold, or of a strip of the infiltrated fornix, removal of a part of the tarsus at the same time that the infiltrated fornix is excised (combined excision or Heisrath's operation, well modified by D. W. White), and extirpation of the tarsus (Kuhnt's operation) are of excellent value, but their description necessarily can not find place in a manual of the scope of the present one.

Treatment of pannus.—Ordinarily pannus subsides when the various measures which have been described, succeed in dissipating the granulated surface of the palpebral conjunctiva. Stubborn pannus is materially benefited by *peritomy*, or more properly, *peridectomy*, which consists in excising a strip of the bulbar conjunctiva about 3 mm. in width, surrounding the cornea, followed by scarification of the vessels at the limbus. In certain cases of advanced and old pannus remarkable results follow the dissection from the cornea of the opaque and vascular tissue. It has to be done with skill and care lest the cornea be perforated. Should there be intense blepharospasm, and on this account dangerous compression of the cornea, or should the palpebral fissure be greatly contracted, the operation of canthoplasty is indicated. It is performed as follows:

One blade of a pair of probe-pointed scissors is introduced behind the external commissure, and the entire thickness of the tissue is divided, making the wound in the skin a little longer than that in the conjunctiva. The wound margins are next separated, and the surgeon loosens the conjunctiva at the apex of the incision and frees it from the underlying tissue. Three sutures are passed, one uniting the extremity of the conjunctival flap to the center of the skin incision, and one suture above and one below, near the angles of the wound. Division of the externus canthus without subsequent introduction of sutures is known as *canthotomy*.

If stenosis of the lachrymo-nasal duct is present, it must be rendered patulous, and chronic dacryocystitis treated by excision of the lachrymal sac.

Prophylaxis.—In camps, cantonments, and barracks there should be systematic and repeated inspection of the soldier's eye after thorough eversion of the lids, and all suspects promptly isolated and kept from mingling with their fellows until the conjunctivas are entirely restored to a normal conditon. It is well known that trachoma is often, if not always, introduced into armies from the outside. It is of paramount importance that the eyes of all recruits should be inspected before they are assigned to duty in the various camps and cantonments. This is particularly true where in our National Army recruits and drafted men come from those regions in which the prevalence of trachoma among the civil population is conspicuous. The ease with which the disease can be communicated,

especially if in the eyes of the carriers purulent secretion is present, is well known, and the careless use of towels, linen, handkerchiefs, and common utensils can not be too strongly condemned. Civilian visitors and workmen coming from areas where trachoma is known to exist should not escape inspection, and if any of them have eyes which are not above suspicion, he or she should be forbidden to enter the military zone.

Pterygium.—This is a fan-shaped hypertrophy of the conjunctiva and subconjunctival tissue, and is generally situated at the inner side of the eyeball, attached by a small head to the cornea, and encroaching upon it for a few millimeters; rarely it passes to and beyond the center. Exposure to dust, smoke, wind, and heat is an exciting cause, and in certain regions where these conditions prevail, for example, in Texas, it is a common affection. If the growth is small, it may be excised, and the gap closed with delicate sutures. Usually, however, the growth must be transplanted. This can be conveniently done, according to the McReynolds' method, as follows:

Grasp completely the neck of the pterygium with strong but narrow fixation forceps. Pass a Graefe knife through the constriction and as close to the globe as possible, and then, with the cutting edge turned toward the cornea, smoothly shave off every particle of the growth from the cornea. With the fixation forceps still hold the pterygium, and with slender straight scissors divide the conjunctiva and subconjunctival tissue along the lower margin of the pterygium, commencing at its neck and extending toward the canthus, a distance of one-fourth to one-half inch. Still hold the pterygium with the forceps, and separate the body of the growth from the sclera with any small, noncutting instrument. Now separate well from the

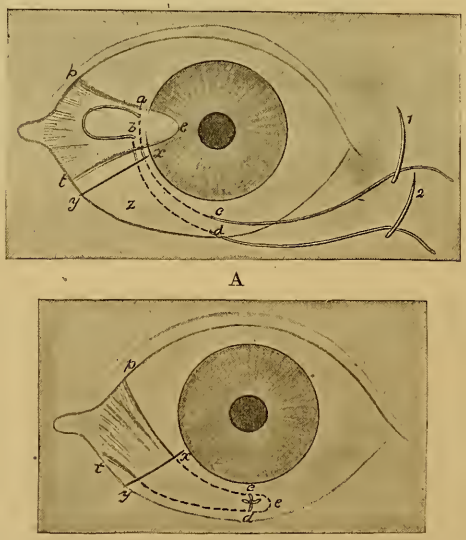

FIG. 10.—McReynolds' operation for pterygium: A, Showing needles 1 and 2, which enter the neck of the pterygium *p t e* at *a* and *b*, and then pass beneath the loosened lower segment of conjunctiva *x y z*, and then emerge at *c* and *d* below the cornea; B, showing pterygium *p t e* fixed by a single stitch *c d* beneath the loosened lower segment of conjunctiva *x y z*, while the former side of the growth *p x t* is covered by the normal smooth, stretched, and thinned-out conjunctiva *p x t*.

sclera the conjunctiva lying below the oblique incision made with scissors. Take a black silk thread, armed at each end with small curved needles, and carry both of these needles through the apex of the pterygium from without inward and separated from each other by a sufficient amount of the growth to secure a firm hold. Then carry these cutting needles downward beneath the loosened conjunctiva lying below the oblique incision made by the scissors. The needles, after passing in parallel directions beneath the loosened lower segment of the conjunctiva until they reach the region of the lower fornix, should emerge from beneath the conjunctiva at a distance of about one-eighth to one-fourth inch from each other. Next, with the forceps, lift up the loosened lower segment of the conjunctiva and gently exert traction upon the free ends of the threads which have emerged from below, and the pterygium will glide beneath the loosened lower segment of the conjunctiva, and the threads may now be tightened and tied and the surplus portion of the thread cut off, leaving enough to facilitate the removal of the threads after proper union has occurred. It is extremely important that no incision be made along the upper border of the pterygium; otherwise it would gape and would leave a denuded space when downward traction is made upon the pterygium.

Tumors and cysts of the conjunctiva.—Small translucent cysts are common; if annoying, they may be excised and the lips of the conjunctival wound closed with delicate sutures. Small conjunctival naevi are important because they may be the origin of a *sarcoma.* This malignant epibulbar growth almost always demands an enucleation of the eye. Occasionally benign tumors, dermoids, recognizable because of the small hairs growing from the apex, lipomas of yellowish color, and papillomas, have their habitat in the conjunctiva. They can readily be dissected from their base in the usual manner.

Subconjunctival hemorrhages (ecchymosis of the conjunctiva).—Independently of those which follow injury, extravasations of blood into the meshes of the conjunctival tissue follow a straining effort—for example, coughing—or may occur during a convulsion. Often taking place during the night and more frequently in the left than in the right eye, they are important indications of chronic nephritis, arteriosclerosis, and sometimes of diabetes. They disappear without treatment, although hot compresses hasten their absorption.

CHAPTER V.

DISEASES OF THE CORNEA AND SCLERA.

The various inflammatory affections of the cornea are included under the general term *keratitis* and may manifest themselves in an ulcerated or nonulcerated form. Of the ulcerated forms of keratitis the following are among those usually encountered:

Phlyctenular keratitis, or keratoconjunctivitis.—This affection, commonly found in children before the age of puberty, also, although comparatively rarely, occurs in adults.

It is characterized by the formation on some portion of the cornea and often on the bulbar conjunctiva of single or multiple *phlyctenules*, which are subepithelial collections of round cells and often are first produced at or near the margin of the cornea. At first gray in color, they speedily become yellow, break down and form ulcers, the so-called *phlyctenular ulcers*. The concomitant symptoms are increased lachrymation, conjunctival hyperemia, and intense photophobia. Usually the subjects have nasal disease, especially an infectious rhinitis, the discharge of which excoriates the lip and edges of the nose. Eczema is often present. Digestive disturbances are common. There is much evidence that the disease is of tuberculous origin, the strain being an attenuated one.

Treatment.—The usual collyria are advisable. The pupil should be dilated with atropin drops, and when the acute symptoms subside the lesions are favorably influenced by introducing a fragment of yellow oxid salve and massaging the eyeball through the closed lid. The diet must be carefully regulated, laxatives administered as required, calomel being especially valuable. Cod-liver oil, sirup of the iodid of iron, and sirup of hydriodic acid are useful remedies. Most important is the treatment of the nasal disease by the most approved methods, medicamental and operative. Frequent spraying of the nasal chambers with Dobell's solution is advantageous. The disease is a stubborn and relapsing one and requires much care, in order to bring it into control and to prevent scars from forming, which would greatly interfere with vision.

Ulcers of the cornea (ulcerated keratitis).—Independently of phlyctenular disease, there are many varieties of ulcers which form on the

cornea and which are of widely different origin. Among those usually encountered, the following groups are the important ones:

1. **Simple ulcer of the cornea.**—This ulcer, sometimes called "pimple ulcer," may have its origin in phlyctenular disease, or arise independently as the result of poor nutrition. Often appearing near the center of the cornea and unassociated with much vascularity, as a small grayish-white opacity staining readily with fluorescin, it also is often found at or near the corneal margin, and suggests in appearance a minute aphthous patch. In these circumstances the patient may have some rhino-pharyngeal inflammation, but more often is the subject of gastrointestinal disturbance, and the ulcer appears after an indiscretion in diet.

Treatment.—Usually a mydriatic is unnecessary unless the iris is congested, when the pupil may be dilated with atropin drops. After staining the ulcer with fluorescin, the stained area should be touched with a cotton-armed probe dipped in a 2 per cent solution of nitrate of silver, or with tincture of iodin similarly applied. This suffices to cure it in a few days. The slight nebula which remains may be dissipated by massaging the cornea with the aid of yellow oxid salve.

2. **Purulent or deep ulcer.**—Such an ulcer may have its situation in any portion of the cornea. It may be preceded by a simple corneal infiltration which has become infected, or arise primarily as the result of a slight injury, e. g., a foreign body, or occur because there is a violent grade of conjunctival infection, for instance, trachoma or gonorrheal ophthalmia, or because the bacterial infection has come from a focal infection in the tonsils, teeth, or sinuses, or in association with systemic infections, for example, influenza, typhoid fever, and especially smallpox.

The lesion usually manifests itself in an area of purulent infiltration, surrounded by a zone of hazy cornea, is irregular in outline and centrally excavated, with a marked tendency to perforate the cornea. Iritis is a usual complication, and pus may collect in the anterior chamber. The pain, both ocular and brow, is severe, and the surrounding conjunctiva markedly congested. Bacteriologic examination of such ulcers will usually reveal staphylococci, streptococci, and sometimes pneumococci and the bacillus of Morax Axenfeld (*diplobacillary ulcers*). Other organisms which have been found are Pfeiffer's capsulated bacillus, bacterium coli, bacillus pyocyaneus (rarely, and then producing an especially severe deep ulcer), and ozena bacillus. Cultures from all purulent ulcers should always be made and the bacterial content studied, as this may govern the treatment. (For treatment consult p. 55.)

Infected or sloughing ulcer (hypopyon keratitis).—Although the ulcer just described belongs to the infected varieties, the present title refers to a special type which is characterized by the manner of its elabora-

tion in that it spreads from one border, and the most important member of the group is the *serpiginous or creeping ulcer of Saemisch.*

In the beginning a nearly central gray area forms, which ulcerates; its margins are sharp, and one, assuming the form of an elevated curve, is more decidedly opaque or yellow than the others, and is known as the *arc of propagation.* Immediately behind it, the ulcer with its gray floor seems deeper than the portion next to the corneal margin.

The surrounding cornea is opaque, and the lesion spreads rapidly, at the same time growing deeper; iritis, iridocyclitis, and hypopyon ensue, and perforation and extensive sloughing of the cornea are likely to occur. Usually the patient complains of severe brow pain and the eye is intensely tender. Vision is reduced to mere light perception.

The *hypopyon* which practically always appears, is a collection of pus in the anterior chamber caused by an aggregation of leucocytes coming from the vessels of the inflamed ciliary body and iris. It is yellow in color, and may be a mere line, or so extensive as to well-nigh fill the chamber.

The bacterial cause of such sloughing ulcers (*hypopyon keratitis*) is the *pneumococcus* (Fränkel-Weischselbaum capsulated diplococcus) occasionally the *diplobacillus of Morax and Axenfeld*, the *bacillus of Petit*, and the *bacillus subtilis.* The microorganisms gain entrance through an abrasion of the cornea, caused by a slight injury, and for this reason these ulcers are often seen in workingmen, especially stone masons and farmers. They are rare in young subjects. The pathogenic organism comes from the conjunctiva, the lid margins, and especially from the lachrymal sac, if it is inflamed.

Herpetic ulcers of the cornea.—Often preceded by a catarrhal conjunctivitis, herpetic vesicles form on the cornea, which rupture and leave an open patch; they have irregular, serrated borders, easily outlined by the fluorescin stain. Sometimes these ulcers form an elaborate branchlike and furrow-shaped ramification (*dendriform ulcers*), and can be well shown by the fluorescin test. Both varieties may accept infection and become purulent. They appear in association with diseases of the posterior nares and pharynx and in association with affections of the respiratory apparatus (pneumonia, bronchitis) and are common after attacks of influenza (grippe). One variety of dendriform ulcer appears to be due to malaria.

Treatment of severe (sloughing) corneal ulceration.—First a smear and culture should be taken from the ulcer and sent to the hospital laboratory for examination. To control iritis atropin drops should be employed, three or four times daily, the conjunctival sac and lachrymal passages irrigated with boric acid lotion, bichlorid of mercury, 1–10,000, or cyanid of mercury, 1–5,000. If there is chronic

dacryocystitis the sac should be excised. The teeth should be inspected, and if defective from tooth-root abscess they should be removed and a search for focal infection in the nares, tonsils, and sinuses should be made, and if found, appropriate treatment instituted. To relieve pain, the frequent use of hot compresses is important, as is the instillation, two or three times a day, of a 5 per cent solution of dionin, to which is added a 2 per cent solution of holocain. Cocain is contraindicated in corneal ulceration as a therapeutic agent. In the absence of associated conjunctival catarrh, or pus coming from the lachrymal sac, a dry, antiseptic, slightly compressing bandage is of advantage, as it tends to prevent impending perforation; it can be removed as often as necessary to make the needed applications, and afterwards reapplied.

To check the spread of the ulcer after it has been outlined by means of fluorescin, this area, the eye having first been holocainized, should be touched thoroughly with liquid carbolic acid, or with trichloracetic acid, by means of a probe on which has been twisted a thin band of absorbent cotton; only the areas stained green and yellow should be touched. If there is much sloughing material in and around the ulcer this may be cautiously curetted with a sharp

Fig. 11.—Paracentesis needle.

small spoon before the acid is applied. Luigol's solution (25 per cent) is preferred by Verhoeff. After the application finely powdered iodoform should be dusted over the surface of the ulcer, or it should be covered with an iodoform wafer, or with bichlorid salve (1–3,000), and the compress bandage reapplied. If the acid application fails to stop the spread of the ulcer it should be touched with the actual cautery, a galvano cautery, using the corneal button, or if this is not at hand, with a knitting needle, or a platinum probe heated red hot in the flame of a spirit lamp or Bunsen burner.

Should bulging of the floor of the ulcer, indicating threatened perforation, be evident, *paracentesis of the cornea* is indicated, and if the hypopyon is fluid this may be evacuated at the same time. It is performed as follows:

The cornea is punctured near its lower margin or, in the case of an ulcer, through its floor with a paracentesis needle constructed with a shoulder to prevent an undue depth of entrance, and inserted at an angle of 45° with the point of contact; or with a broad needle held flatwise, the point being kept well forward so as to avoid wounding the lens. By rotating the needle slightly on its long axis the lips of the opening are separated and the contents of the aqueous chamber more readily escape. The needle must be withdrawn

slowly, lest a sudden gush of aqueous cause prolapse of the iris. The eyeball may be steadied with a spring speculum or fixation forceps, provided the former does not put too much pressure on the globe, or the lids may be separated by the surgeon's fingers. If it is necessary to reopen the wound the probe end of the instrument should be used.

Should the hypopyon be an extensive one and also tenaceous, Guthrie's section (usually called Saemisch's section) may be performed, as follows:

The conjunctiva below the cornea is seized with fixation forceps, a cataract knife with its cutting edge forward is entered on one side of the cornea and carried across the anterior chamber to the opposite side, where counterpuncture is made. If, as Schwenck suggests, the knife is gently pressed backward and then rotated on its long axis, a gap will be made at both ends of the incision, and the anterior chamber fluids will drain slowly and relieve the tension and prevent sudden springing forward of the iris when the knife edge replaced, is made to cut forward through the ulcer. If the hypopyon is tenacious, it may be removed with delicate forceps, or washed with an irrigator charged with physiologic salt solution. A light bandage is applied after the surface of the incised ulcer is dusted with powdered iodoform or nosophen, or covered with bichlorid salve.

Should the bacterial examination reveal the Morax Axenfeld bacillus, the preparation of zinc (see p. 40) should be thoroughly applied. If the pneumococcus is discovered, in recent times ethylhydrocuprein (optochen) has been recommended. It may be applied directly to the ulcer in a strength of from 1 to 2 per cent, or used as a watery solution every hour, or employed in an ointment combined with atropin. Autogenous vaccins (bacterins) prepared from pure cultures of the organism present in the ulcer occasionally appear to be of distinct advantage. The dose varies from 50,000,000 to 300,000,000. There is, however, much difference of opinion in regard to their value. Stock vaccins are not recommended. Subconjunctival injections of mercuric bichlorid (10 minims of a 1–4,000 solution, or of cyanid of mercury (1–2,000) are also advised by some surgeons.

The patient's nutrition should be maintained at the highest level; iron, quinin, syrup of hydriodic acid, and if the circulation is below par, digitalis and strychnia may be administered. Should the pain be severe, morphia or codein are indicated.

Results of corneal ulceration.—Almost always after corneal ulcers, scars, delicate or dense, as the case may be, form. If slight, it is called a *nebula*, or macula; if dense, a *leukoma*. Should the latter have followed an ulcer which has perforated the cornea and the iris is adherent to it, it is called an *adherent leukoma*, or if only a strand of iris is attached to the point of a small previous perforation, it is

named an *anterior synechia.* Because the scar tissue which fills in a large corneal ulcer in the process of healing may fail to withstand the intraocular tension, it becomes distended and constitutes a *partial staphyloma*, or if the scar tissue has been extensive, a *total staphyloma.*

FIG. 12.—Beginning staphyloma of cornea following perforation of infected ulcer.

Treatment.—Nebulas and small thin maculas sometimes yield to the influence of massage with yellow oxid of mercury salve, especially if 2.5 per cent of dionin is added to the ointment, or the dionin may be used separately in a 5 per cent liquid solution. Thick scars are uninfluenced by such treatment. Thiosinamin internally in half-grain doses has been tried without avail. Injections of a 15 per cent solution of fibrolysin have been reported by some surgeons to be of advantage. To prevent the formation of staphyloma, a pressure bandage should be tried, or if the tension is high, an iridectomy, or repeated paracentesis of the cornea. If the staphyloma is unsightly, or subject to recurring attacks of inflammation, the eyeball should be enucleated, and a gold or glass ball implanted in Tenon's capsule to improve the stump. Small scars may be tattooed with India ink, with cosmetic advantage. If the scar is central and the surrounding cornea clear, an optical iridectomy is indicated.

FIG. 13.—Complete staphyloma of the cornea.

Exposure keratitis.—This form of keratitis, in which there is a desiccation and exfoliation of the corneal epithelium, may occur from imperfect closure of the lids, for example, in facial palsy, in prolonged illness, in exophthalmic goiter, and exophthalmos from other causes (p. 99). After removal of the Gasserian ganglion for relief of trifacial neuralgia, and in some cases of periostitis of the orbit and fracture of the skull which injures the fifth pair of nerves, a *necrotic keratitis* (*neuroparalytic keratitis*) may develop, the cornea being anesthetic, due to irritative changes in the degenerating nerve. Under either of the conditions named, the cornea should be covered with a

glass or mica shield, or the lids should be stitched together, after a strip of the ciliary margin at the center has been freshened. This keeps the cornea covered, but permits its inspection on either side of the central attachment, and facilitates the introduction of irrigating fluids.

Among the most important of the nonulcerated forms of keratitis are (*a*) *parenchymatous* (*interstitial*) *keratitis*, due to syphilis, inherited or acquired, and tuberculosis (see p. 95); (*b*) *parenchymatous keratitis*, due to injury (see p. 114); (*c*) *circumscribed central keratitis*, due to constitutional troubles. In the last named affections in general terms there is a diffuse or circumscribed infiltration of the corneal layers, sometimes of those which are superficial, and sometimes of those which lie deeper. Over these opacities the epithelium is roughened, occasionally slightly edematous, and usually hazy. The general effect is to give the cornea a gray appearance, resembling ground glass. Associated with this corneal change, there are usually ciliary congestion and an area of injected vessels around the cornea. There may be hyperemia of the iris and sometimes iritis.

The *cause* of these types of keratitis, exclusive of those due to syphilis and injury, is not always discoverable. Some are undoubtedly due to the effects of overeating and drinking, which may result in the disturbed metabolism which lies at the bottom of the gout and certain types of so-called rheumatism; some are probably an expression of gastrointestinal intoxication; others appear to be due to focal infections in the buccal mucous membrane, tonsils, sinuses, etc., and to systemic infections.

Treatment.—This includes removal of the cause, regulation of the diet, laxatives, and the free drinking of diuretic waters. Locally atropin drops and dionin are of advantage, but watch must be kept that the intraocular tension does not rise. Massage with yellow oxid of mercury salve may be tried.

Deep-seated episcleral congestions.—Reference to page 26 will show that congestion of the episcleral vessels differs materially from congestion of the posterior conjunctival vessels. These congestions may indicate disease of the subjacent structures (ciliary body or choroid) or belong to the symptomatology of inflammation of the episcleral and scleral tissue, or arise in association with various forms of keratitis.

Should there be distinct circumscribed swelling of the conjunctival (episcleral) tissue, especially on the temporal side of the sclera in its ciliary area, associated with edema of the conjunctiva and a congestion of somewhat dusky appearance, and usually tender to the touch, there is an episcleral infiltration, and the condition is known as *episcleritis*. Should the injection have a bluish-red color, often

diffuse, but occasionally circumscribed in patches of a violaceous tint, through which a nodular condition may be noted, and there is also evident (not always, but usually) a crescentic area of infiltration in the neighboring cornea, the condition is known as *deep scleritis*.

Causes.—These are varied. Among those usually elucidated are exposure to cold, and especially to cold driving winds, rheumatism, gout, sinus infection, tuberculosis; rarely gonorrhoea and syphilis (gummatous scleritis).

Treatment.—Elimination of the cause, atropin drops if the iris is hyperemic or inflamed, hot compresses, dionin (2–5 per cent), and internally, after a brisk purge, full doses of aspirin or salicylate of sodium. Naturally in specific cases the usual remedies are indicated; if a tuberculous origin is demonstrated, injections of tuberculin may be tried.

CHAPTER VI.

DISEASES OF THE IRIS AND CILIARY BODY.

Inflammation of the iris (*iritis*), or of the iris and ciliary body (*iridocyclitis*), for they are usually united in their diseases, may be described under one heading.

Symptoms.—The following symptoms are common to most cases of iritis and iridocyclitis: (1) *Change in the color of the iris;* (2) *pericorneal injection*, in the form of a fine, pink zone surrounding the cornea about one-fourth of an inch (6 mm.) in diameter, known as ciliary congestion, and almost exactly overlying the position of the ciliary muscle; (3) *disturbance of the normal contour and reactions*

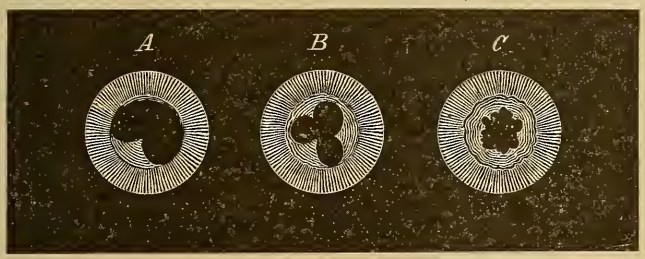

FIG. 14.—Various forms of posterior synechiæ: *A*, Single attachment; *B*, multiple attachment forming the so-called "ace-of-clubs" pupil; *C*, irregular annular attachments.

of the pupil, which, at first contracted, later becomes irregular, due to the attachment of tonguelike projections from the pupil margin to the lens capsule, these being the so-called *posterior synechiae*, and there may be only one, or several, or a complete annular attachment, and they are best studied by means of oblique illumination, and are especially evident after the use of a mydriatic; (4) *irregularities in the iris surface*, due to deposits of fibrin or the formation of nodules; (5) *haziness of the cornea* and, in some cases, deposits of dotlike character, often accumulated in a triangular manner on the posterior surface of the cornea (*descemetitis*, *keratitis punctata*), especially if the ciliary body and choroid are involved (*uveitis*); (6) *changes in the character of the anterior chamber*, slight turbidity of the aqueous; sometimes exudation, often lying on the surface of the lens.

The subjective symptoms include: Pain in the eye, throughout the supraorbital region, and not uncommonly in the infraorbital region, and usually in the teeth; disturbance of vision; tenderness of the globe and a certain amount of dread of light and lacrimation.

Diagnosis.—In spite of the fact that iritis presenting most of the symptoms just described should be easily recognized, it is not infrequently mistaken for, or confounded with, other acute inflammations of the anterior part of the eye. The following tabular arrangement presents the distinguishing features:

Acute iritis.	Simple conjunctivitis.	Phlyctenular kerato-conjunctivitis.	Acute glaucoma.
1. Discolored iris.	1. Iris normal.	1. Iris normal	1 Iris congested; periphery pushed forward
2. Pupil at first small, after atropin, posterior synechia.	2. Pupil normal.	2. Pupil normal.	2. Pupil oval, semidilated, immobile, no synechiae.
3. Anterior chamber usually normal in depth, sometimes deeper than normal containing exudate.	3. Anterior chamber normal.	3. Anterior chamber normal.	3. Anterior chamber very shallow; sometimes abolished.
4. Cornea often hazy and dots on posterior surface.	4. Cornea transparent.	4. Cornea often harbors phlyctenules.	4. Cornea very steamy, "needle-stuck" appearance and insensitive.
5. Pink zone of ciliary congestion surrounding cornea, fading toward fornix.	5. Coarse general conjunctival congestion, less marked near cornea.	5. Often general but not intense injection.	5. Usually intense congestion, ciliary, episcleral and conjunctival.
6. Conjunctiva injected but usually transparent, sometimes chemotic.	6. Conjunctiva diffusely reddened, opaque and velvety, slightly chemotic in severe cases.	6. Diffuse injection, with special lines of vessels running to phlyctenules.	6. Conjunctiva congested, often chemotic.
7. Lacrimation, but no mucopurulent discharge in uncomplicated cases.	7. Free mucopurulent discharge.	7. Excessive lacrimation.	7. Lacrimation, but no pus or muco-pus.
8. Tension normal in uncomplicated cases.	8. Tension normal.	8. Tension normal.	8. Tension very high; eyeball often very hard.
9. Tenderness on pressure.	9. No tenderness.	9. Tenderness not marked.	9. Usually great ciliary tenderness.
10. Severe brow pain, radiating to temple and to teeth.	10. Feeling of foreign body in eye; no pain.	10. Acute general irritation.	10. Intense eye and head pain, often with nausea.
11. Vision defective and dim.	11. Vision unaffected except from gathering mucus.	11. Vision defective from corneal involvement.	11. Marked dimness of vision, usually reduced to mere light perception.

In point of fact, in making the differential diagnosis in these affections, the condition of the pupil is practically the deciding point, together with, in the case of glaucoma, the great rise of intraocular pressure.

Course, complications, and prognosis of iritis (iridocyclitis).—An iritis may pursue an acute course, reaching its termination in four to eight weeks, or be chronic from its onset and last, in a slow and insidious inflammation, for long periods of time. The termination of an iritis may be entirely favorable. The inflammatory adhesions disappear and the iris regains complete mobility, only a few traces of iris pigment being seen on the capsule of the lens. On the other

hand, more or less complete attachment causing distortion and inequality of the pupil may remain; or deposits of exudation may directly occlude the pupil and lie upon the capsule of the lens; or the tissue of the iris may show areas of atrophy and exhibit a bleached or grayish aspect.

Should the exudation in the pupil remain (*occlusion of the pupil*) or should the entire pupil rim of the iris remain bound to the lens capsule (*exclusion of the pupil*) the filtering processes of the eye are disturbed and secondary glaucoma results. Often in severe iritis and iridocyclitis the vitreous begets opacities and there is inflammation of the choroid, retina, and even of the optic nerve.

If, as in certain types, the entire uveal tract is involved, iris, ciliary body, and portion of the choroid, and marked triangular deposits appear on the posterior surface of the cornea (*Keratitis punctata*, *Descemititis*) the process is denominated *uveitis*, which, to all intents and purposes, is an elaborate iritis or iridocyclitis and has an origin like the simpler varieties of the disease.

Causes and clinical types of iritis (iridocyclitis).—Cases of iritis may be classified, according to the supposed etiology, as follows: *Syphilitic*, *rheumatic*, *gouty*, *gonorrheal*, *tuberculous*, *septic*, *autotoxemic*, *traumatic*, and *sympathetic* iritis, a convenient but not strictly scientific arrangement.

The most usual causes of acute iritis are syphilis (described on p. 91), infections from mucous membranes—focal infections, autotoxemia in association with disorders of nutrition and constitutional disorders, most of the cases having formerly been classified as rheumatic iritis, and gonorrhea. Iritis and iridocyclitis are also found in connection with gout, diabetes, tuberculosis, and infectious diseases; for example, influenza, variola, meningitis, typhoid fever, etc. Iritis is also caused by trauma (p. 70) and by sympathetic disease (p. 75).

Treatment.—The management of each case of iritis (iridocyclitis, uveitis) must include (*a*) a careful clinical history and a search for the causative factors and their elimination, (*b*) the local remedies, and (*c*) the constitutional treatment.

I. Even in the absence of data in the clinical history, syphilis must always be suspected, and a Wassermann test of the blood must always be made. If positive, the treatment includes the usual remedies (see p. 92). A test for tuberculosis is advisable, either a Von Pirquet test or a diagnostic tuberculin test. The primary source of focal infections, now known to be the cause of iritis in many, if not in the majority, of the cases, exclusive of syphilis, more frequently resides in a chronic septic process in the mouth (pyorrhea alveolaris), in the teeth (tooth-root abscess), in the tonsil, in the naso-pharynx, in the accessory nasal sinuses, especially the ethmoid; in the stomach and intestines, in the urethra, in the prostate, and in the skin (furuncles,

boils). The sinuses and teeth can not be regarded as free from disease unless an X-ray examination is made, and the search for foci of infection, often deeply placed in the tonsils, must be a thorough one.

While acute rheumatism (rheumatic fever) is practically never a cause of ordinary plastic iritis—that is, a nonsuppurative process—many iritic patients are the subjects of so-called chronic rheumatism, chronic joint rheumatism (polyarthritis), and muscular rheumatism, i. e., myalgia, appearing in the form of lumbago, pleurodynia, etc., and this is the reason these types of iritis were formerly called "rheumatic iritis," but are now classified under the term "toxic or autotoxemic iritis." In these patients the iritis is often started by sudden and severe exposure to cold—hence the common expression, "catching cold in the eye."

Gonorrhoea is a frequent cause of iritis, and there may be a long interval between the acquisition of the gonorrhoea and the iritis—frequently many years; in other words, the iritis does not necessarily coincide with the acute attack of gonorrhoea. Sometimes arthritis and iritis occur at the same time; sometimes an arthritis intervenes between the gonorrhoeal attack and the iritis. Always in acute iritis not otherwise explained, the blood should be examined for a complement-fixation reaction, and the posterior urethra for gonococci.

It will be seen that on these clinical examinations and laboratory tests depends much of the success of treatment, and it is evident that the elimination of focal infections, as described, is of paramount importance. Diseased teeth should be removed and the buccal mucous membrane sterilized, the infected tonsillar crypts cleaned out, or the tonsils removed, ethmoiditis brought into control, etc.

II. Mydriasis should be persistently maintained, until all ciliary irritation and flushing have disappeared, by instilling two drops of an atropin sulphate solution gr. iv to f℥i (0.26 gm. to 30 c. c.) every three or four hours. Should atropin irritation arise, which occasionally happens, scopolamin hydrobromate 2 grains (0.139 gm.) to the ounce (30 c. c.) may be used, or hyoscyamin in similar strength, care being taken to close the tear passage by pressing on the corner of the eye during and after each application. Frequent irrigation with hot physiologic salt solution, or equal parts of this fluid and boric acid solution, are soothing applications. Pain should be relieved by hot compresses applied with a pad of surgical gauze maintained at a temperature of 120° F. (49 C.), 20 minutes during each hour, or a solution of acetate of lead ℥i (3.9 gm.), powdered opium ℥ss (15.5 gm.), and hot water Oj (474 c. c.) may be similarly used; or a 5 per cent solution of calcium chlorid. Dionin drops (5 per cent) enforced with holocain (2 per cent) have an excellent effect as an analgesic, two drops four times a day for three days, then intermitted for three,

and again repeated, etc. Bloodletting from the temple by means of Sweedish leeches, or an artificial (Heurteloup) leech is often of great service; in their absence wet cupping of the temple may be employed. The temptation to relieve pain by administering morphia hypodermatically is ever present. Occasionally this may be required, but certainly should not be a routine practice. Codein, associated with aspirin, may be used with advantage as required.

During the period of mydriasis the intraocular tension must be frequently tested by palpating the globe (p. 80), and if it should rise, as sometimes happens, the atropin drops must be temporarily stopped; sometimes, though rarely in uncomplicated iritis, paracentesis of the anterior chamber (p. 56) is required to control the process.

III. Each patient with iritis should at the beginning of the treatment receive a full dose of blue mass or calomel, in broken doses, followed by a saline, and during the course of the attack laxatives should be administered as required. Almost all types of iritis are favorably influenced by the administration of mercury, for example, the protiodid, even though they are not syphilitic in origin, the treatment of which type is fully described on page 90. Also iodid of potassium, either alone in 5 or 10 grain doses three times a day or combined with bichlorid of mercury (mixed treatment), is useful. Of great importance is the administration of salicylate of sodium, or aspirin in full doses; of the former 60 to 80 grains (3.9–5.2 gm.) daily, and especially so in the so-called rheumatic (autotoxemic) and gouty types of iritis. Free drinking of diuretic waters is recommended. In stubborn and relapsing types of iritis, especially those of gouty, autotoxemic, and gonorrheal origin, profuse sweats by means of pilocarpin, given hypodermically, or with the aid of an ordinary hot chamber or cabinet, afford great relief. The administration of vaccins (bacterins) has been advised in some special types of iritis and iridocyclitis, for example, in gonorrheal iritis a Neisser bacterin in the dose of 25,000,000–50,000,000 occasionally stimulates a rapid subsidence of the symptoms; in iritis from focal infection, especially in those types which are named uveitis, autogenous vaccins have been highly commended by some surgeons, and even stock vaccin of the ordinary bacteria. Tuberculous iridocyclitis is also somewhat amenable to tuberculin treatment. Some cases of chronic iritis, especially if secondary glaucoma is threatened, and of relapsing iritis, may require iridectomy.

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CHAPTER VII.

INJURIES OF THE EYE AND SYMPATHETIC OPHTHALMIA.

Injuries of the eyelids.—Incised, lacerated, punctured, and contused wounds, edema, emphysema and ecchymosis of the lids are the ordinary results of accidents and injuries. Incised wounds in the line of the direction of the fibers of the orbicularis result in the least visible scar, owing to the absence of gaping. Such injuries are often inflicted by broken glass (a broken spectacle lens, for example) or china, by a knife, or other sharp instrument, and by a thin sliver of metal.

Treatment.—Accurate approximation of the edges of the wound should be secured with catgut or silk sutures. Even considerable laceration may heal with very little deformity.

Foreign bodies in the eyelids.—Fragments of glass, shot, pieces of iron or steel, portions of wire, particles of stone, and splinters of wood may penetrate the tissue of the eyelids and occasionally remain undetected for long periods of time. They may become encysted, or, as a result of infection, give rise to a *lid abscess.* If the foreign body is composed of iron or steel it may be removed by means of a magnet.

Burns of the eyelids are commonly inflicted with hot water, caustics (lye and lime), acids, or are caused by the explosion of powder.

The first agent produces the ordinary vesiccation, and the treatment should consist in the application of oil, while the pain may be materially relieved by using locally a lotion of carbonate of soda or, better, the moistened powder itself.

Burns caused by the other materials are especially dangerous on account of the almost invariable involvement of the cornea and conjunctiva. Immediately after a *powder burn*, all loose powder should be removed, and, if possible, each grain picked out of the skin with a fine needle. The application for ordinary burns may then be used. Peroxide of hydrogen has also been employed to remove powder grains, and is most efficient. It may be applied in full strength or in a solution of 3 parts to 1 part of glycerin, or rubbed over the affected area vigorously.

The formation of ectropion after wounds of the lid, and after burns of the same region and the surrounding facial area, has been referred to on page 34. Its prevention in large part depends in wounds upon the accuracy with which the cut or lacerated parts are approximated, and in burns upon the depth of the process and the care in treatment; often it can not be prevented, and must be remedied by later plastic work.

Injuries of the conjuctiva—(*a*) **Foreign bodies.**—A small particle of coal, ash, or dust is easily removed if lodged upon the lower portion of the conjunctiva; but if it finds its way beneath the upper lid, and is situated far back under the retrotarsal fold, it may not come into view when the lid is everted unless the fold is pushed into prominence. If the foreign body is attached to the tissues it may be necessary to dislodge it with the point of a needle or with a spud. Cocain or holocain will render this operation painless.

(*b*) **Wounds.**—These may be part of a serious injury involving the lid or deeper structures of the eye; more rarely they occur as simple lacerations, confined usually to the bulbar portion. In suitable cases, after proper cleansing, the lips of the wound should be drawn together with a few sutures.

(*c*) **Burns.**—These are commonly inflicted with lime (mortar or quicklime), molten metals, powder, and acids, and are especially serious because of the deformity which the subsequent contraction is likely to produce, or on account of the development of a symblepharon. Ulceration of the cornea, hypopyon, and even panophthalmitis may result. The prognosis of such injuries is always grave.

All foreign substances must be removed at once, and if lime has been the injuring agent, this is best accomplished by forcible irrigation of the conjunctival sac with clean water or thorough cleansing of the eye with oil introduced with a syringe into the cul-de-sac. For acid burns an alkaline lotion is usually recommended. The subsequent treatment consists in the instillation of olive or castor oil or liquid albolene, and atropin drops, to prevent secondary iritis if the cornea is much inflamed; atropin may be incorporated with liquid vaselin and placed in the cul-de-sac. Powder grains are frequently embedded in the conjunctiva; they can not be picked from their beds; usually the larger ones can be excised.

Injuries of the cornea—Traumatic keratitis.—These comprise: (1) Foreign bodies, (2) erosions, (3) wounds, and (4) burns and scalds.

Foreign bodies, as particles of sand, cinders, fine splinters of iron, and bits of emery, may either lodge upon the epithelium or become embedded in the substance of the cornea. If they are sharp, like a splinter of iron or small thorn from a chestnut burr, they may partially penetrate the membrane.

To remove an embedded foreign body a drop of 4 per cent solution of cocain or a 2 per cent solution of holocain is instilled, the upper and lower lids are held apart with the thumb and forefinger of the surgeon's left hand, while with the right hand he takes a carefully sterilized needle, or a spud, and lifts the body from its position with as little injury as possible to the cornea. The area should afterwards be inspected by means of a 2-inch lens and oblique illumination. In any case in which the operator is not sure that he has removed the foreign substance he may resort to the fluorescein method. If the substance has been iron or emery, a small, rustlike spot will often remain.

If the spicule has partially penetrated, it may be necessary to pass a broad needle through the cornea behind it to secure a surface against which to work and to prevent the manipulations from pushing it entirely through the cornea and into the anterior chamber.

After the removal of the foreign body, the resulting irritation may be allayed by a drop of atropin; the use of a bandage for a few days will facilitate the healing of the ulcer. Disinfection of the conjunctival cul-de-sac with a bichloride lotion (1:8,000) or one composed of cyanide of mercury (1:2,000) is important. If in the attempt to remove the foreign body much abrasion of the cornea has occurred, great care should be exercised to prevent infection. Darier recommends a collyrium of cyanide of mercury which contains dionin.

Erosions.—A superficial loss of epithelium caused by the contact of a sharp body, for example, a finger nail, a twig, etc., in itself may be insignificant, but may lead, through septic infection, to a severe ulceration, particularly if the injured eye is exposed to the discharge from an inflamed lachrymonasal apparatus.

Sometimes erosions are very large, as much as one-half of the corneal epithelium being rubbed off. The pernicious practice of taking a cotton-armed probe and endeavoring by vigorous rubbing to remove a foreign body is often responsible for these large abrasions. Small abrasions are often very hard to detect, but can be instantly found by instilling a few drops of fluorescin solution (2.5 per cent), and flushing the eye afterwards with boric acid lotion. The abraded area will stain a bright green. Abrasions may assume a troublesome relapsing character, the attacks usually coming on early in the morning on awakening.

Treatment.—This should be most careful, as abrasions may be the port of entry of infection which will lead to serious corneal ulceration. The conjunctival sac should be thoroughly flushed with bichloride of mercury (1:8,000), or cyanid of mercury (1:2,500), the pupil dilated with atropin drops, and a few drops of holocain (2 per cent) instilled. Following this a light compress bandage should be applied until the epithelium is renewed and fluorescin no

longer produces a stain. In relapsing erosions holocain is of great advantage, and a drop of liquid vaselin at night is useful.

Wounds of the cornea and corneoscleral junction.—These naturally comprise *nonpenetrating* and *penetrating wounds*. The former are managed exactly as in an abrasion of the cornea (p. 69). A *penetrating wound*, especially one located at or near the corneoscleral junction, is usually complicated by *prolapse of the iris*, and often of the ciliary body tissue; the anterior chamber may be partly filled with blood, which may also be present in the vitreous.

Treatment.—The history of the accident must always be carefully studied, and the character of the wounding substance, whether of glass, stone, iron, or steel, etc.; whether the implement was a large one, for example, a cold chisel or head of a hammer; or whether the patient noted if a fragment of the tool was broken off, etc. Even if the history is negative as to retention of a foreign body within the globe, it can not be entirely trusted, and an X ray of the eye is imperative, which will locate a body within the eye unless it is a splinter of wood or fragment of glass free from lead. In the absence of X ray examination, a large magnet (Haab, Lancaster, or Sweet model) should be tried. If the body is a metallic one, a response, either by pain or by movement of the eye in the direction of the magnet, is likely to occur, and immediate removal may be undertaken. Occasionally the media are clear and ophthalmoscopic examination is possible; the iris surface should be carefully inspected by means of oblique illumination, which may reveal a body entangled in the meshes of the iris. Should the surgeon be entirely satisfied that no foreign body is retained within the globe, he proceeds as follows:

The prolapsed iris is disentangled from the wound, seized with forceps, drawn forward and abscised (only rarely is it possible to replace it without excision); the edges of the wound are freed from foreign tissue, and if accurately coapted, after instilling a drop of atropin solution, a bandage is applied. If the wound is irregular and tends to gape, it is of great advantage to cover it with a flap of conjunctiva, dissected from the neighboring bulbar expanse, slid in place and anchored with two fine sutures. Beneath the flap the wound heals well, and infection is prevented.

Should the lens have been injured, a *traumatic cataract* forms, which may be removed at a later period, or, if there is swelling of the cortex, be immediately evacuated. Following the procedure described, after bandaging the eye, constant iced compresses are advantageous for at least 24 hours, and for periods of 20 minutes each waking hour for a second 24 hours. The administration of small doses of calomel is most useful.

Burns and scalds are produced by the contact of acids, lime, molten metal, and hot water or steam. Sometimes the burn may be superficial, and the whole surface epithelium be changed into a white scum, which presents a most alarming appearance. The destroyed tissue, however, may be replaced by a new layer of epithelium. Burns with slaking lime and molten metal are liable to result in disastrous consequences, and may be followed by sloughing keratitis and even panophthalmitis, and, if the burns are located at the limbus, elevation of intraocular pressure may develop.

Ammonia burns of the eye are of serious import, and even where the injury originally seems to be comparatively slight, there may develop later rapid necrosis of the cornea, with exudation in the anterior chamber, followed by blindness. There is a certain similarity between *carbolic acid burns* and those caused by ammonia, but the ultimate prognosis is less gloomy.

Severe corneal and conjunctival burns have been caused by *exploding golf balls*, so-called "zodiac" and "water-core" balls, containing caustic contents, *e. g.*, barium sulphate, sodium hydrate, soap, free alkali, and zinc chlorid. The *treatment* of burns and scalds has already been described.

Treatment.—The treatment of these burns does not differ from that described in connection with conjunctival burns. To endeavor to prevent adhesions between the lids and ball and the formation of symblepharon many procedures have been tried, e. g., covering the area with gold-beater's skin, very thin rubber, and the skin which lines the inner surface of an eggshell—all of which are rarely successful. The daily separation of the adhering raw surfaces by passing between them a probe and irrigating freely with an antiseptic lotion and keeping the parts covered with boric-acid ointment or bichlorid salve (1–5,000) should be tried, but in spite of this procedure symblepharon is apt to form, especially after acid and lime burns.

Contusions of the eyeball.—These injuries, usually the result of a blow, for instance, from a fist, the impact of a flying object, for example, a cork or piece of wood, may be followed by (*a*) ecchymosis of the lid ("black eye") and a general scleral congestion, (*b*) hemorrhage into the anterior chamber, and, after severe blows (*c*) rupture of the ciliary margin of the iris (see p. 117), hemorrhage into the vitreous (compare p. 72), and hemorrhage into the fundus, with or without rupture of the choroid. Hence, after contusion of the globe careful examination of the eye externally and by means of the ophthalmoscope should be undertaken.

Treatment.—The effects of simple contusions pass away quickly, hot compresses or applications of Pond's extract, or lead water and laudanum being sufficient. Blood in the anterior chamber is usually

rapidly absorbed under the influence of hot compresses, the internal administration of iodid of sodium, and a light compressing bandage, and even vitreous hemorrhages may disappear as the result of the same treatment. The patient should remain in a recumbent position until the extravasated blood has been absorbed.

Penetrating injuries of the eyeball through the sclera.—Wounds of the sclera may be caused by a sharp implement (knife, scissors, broken glass, etc.) or foreign body (chip of iron or steel, bullet, etc.), or they may result from a blow on the bulbus on the inner side and above, rarely downward and out, causing *rupture of the sclera*, usually found 3 mm. from and concentric with the corneal margin. The rupture may be exposed through a rent in the conjunctiva, and is then said to be "compound," or it may be concealed by the conjunctiva, which is untorn.

If the wound has *perforated* the sclera, two complications are liable to be present, loss of a portion of the contents of the globe and injury to the inner coats, and the introduction into the eye of septic material which will cause destructive inflammation.

Symptoms.—A perforating wound of the sclera, if sufficiently large, causes loss in the tension of the globe, hemorrhage into the vitreous, or, it may be, into the anterior chamber, and the appearance of dark tissue in the wound, representing, according to its situation, portions of the choroid or ciliary body; a bead of vitreous is likely to be present. A small perforating scleral wound may be hidden by the overlying contused and swollen conjunctiva. Usually the intraocular tension is lower than normal. Rupture of the sclera is commonly associated with grave lesions in other portions of the eye—separation of the retina and extensive tears in the choroid and iris.

Prognosis.—This depends upon (1) the extent and situation of the wound and amount of escape of vitreous; (2) the presence or absence of septic material upon the implement or body which inflicted the injury; (3) whether a foreign body has remained within the globe; and (4) the character of the foreign body which may have entered. It is evident that even a trifling perforating wound, unattended with loss of vitreous or prolapse of the inner coats, may be a point of entrance of infection.

Treatment.—Having carefully ascertained that no foreign body is within the globe, the eye should be disinfected with a solution of bichlorid of mercury (1:5,000), and the edges of the wound, after all foreign substances have been removed, penciled with a stronger solution of the same drug (1:2,000) or with a 5 per cent solution of iodine. The overlying conjunctiva is next drawn together with several fine sutures. The eye is closed with an antiseptic compressing bandage and the patient is put to bed. Iced compresses are an advantage during the early stages of the treatment. At the end of

48 hours the wound may be inspected and the dressings renewed. In larger wounds usually scleral sutures are not necessary, conjunctival sutures being sufficient; the sutures may be removed at the end of a week if the healing has progressed favorably. In some instances, in spite of kind healing of the scleral wound, there are subsequent detachment of the retina, vitreous change, and shrinking of the eyeball, but apparently hopelessly injured eyes may be saved by careful aseptic surgery.

In the event of a scleral wound being extensive, with much loss of vitreous and collapse of the coats, especially if the ciliary body is involved and sight practically gone, or if the endeavors to remove the foreign body have been unsuccessful, enucleation should be performed to avoid the dangers of sympathetic inflammation in the fellow eye.

Foreign bodies within the eyeball.—If the wounding substance has been small—*e. g.*, a chip of steel, a splinter of glass, a particle of dynamite cap, shrapnel, or bullet—endeavor should be made to ascertain whether this has penetrated the globe and remained within it, or has passed entirely through the eyeball and buried itself in the tissues of the orbit. Foreign bodies may be embedded in any of the structures of the eye and are frequently found in the vitreous. If loose, they tend to gravitate to the lowest part of the vitreous and rest upon the posterior part of the ciliary body. *Double perforation* of the eye is not uncommon as the result of a bullet wound or one caused by the explosion of a dynamite cap, but less frequent if the foreign body is a chip of iron or steel. X-ray examination should show whether the foreign body has passed entirely through the posterior scleral wall or is embedded partly within and partly without the scleral covering.

Perforating injuries of the eye with pieces of copper may result in purulent inflammation merely by the chemical action of the metal. Foreign bodies may be tolerated for long periods of time, with good vision, in the background of the eye, but can never be trusted unless they are small and the accompanying lesions trifling; in other circumstances they are liable to cause degenerative changes. However, small fragments of glass have remained for years within the globe without creating untoward symptoms.

Unfortunately, blood in the vitreous and anterior chamber, or opacity of the lens, is apt to obscure the media to such a degree that ophthalmoscopic examination is not of much service; but if the media are clear, this method may be the means of detecting the foreign body. Air bubbles in the vitreous are suggestive, but not pathognomonic of a foreign body in the globe. An attempt at locating the body may be made by observing the situation of the wound, the condition of the capsule of the lens, the probable direction which the foreign substance

took on making its entrance, by a search for points of tenderness and for a scotoma in the field of vision. Small foreign bodies, *e. g.*, a fragment of steel, or shrapnel, may penetrate the globe and leave practically no trace of their point of entry. This is an important matter, and constitutes a frequent experience in the present war. If there is any doubt, a skiagraphic examination should be undertaken, and in the majority of instances (pieces of wood excepted) the Röntgen rays will readily reveal the presence and position of the foreign body. Of the various methods devised for this purpose, the one elaborated by W. M. Sweet is most satisfactory. The method of McKenzie Davidson and Dixon's modification of the Sweet method are also excellent.

Having satisfied himself of the presence and position of a non-metallic foreign body within the globe, the surgeon may attempt to extract it through the original wound with delicate, carefully disinfected forceps, or through a new wound made in the most favorable situation. But in some instances a small fragment of sterile glass, for example, difficult or almost impossible to reach had better be allowed to remain rather than to make matters worse by the frequent introduction of instruments into the vitreous chamber in the effort to extract it.

Should the foreign body be a metallic one—and all eyes with penetrating wounds should, if possible, be submitted to an X-ray examination, and if this demonstrates the presence of a foreign body it should be localized by an X-ray expert—two methods of operative procedure are at the disposal of the surgeon: (1) Magnet extraction of the body through an incision made into the sclera at that portion which most nearly approaches to the position within the globe which the piece of magnetic metal occupies, or if this provides satisfactorily a channel of exit through the original wound of entrance (direct extraction). To incise the sclera, a thin Graefe catarcat knife is used, and an incision as small as possible is made in the line of the scleral fibers, after a flap of conjunctiva has been reflected, through which two or more delicate silk sutures are passed. Next, the extension point of the magnet (a Sweet or Lancaster model will suffice) is placed against the scleral wound, which may be gently retracted with a small, nonmagnetic retractor, and the current turned on. In many instances, if it has not been too long within the eye and has not been covered with exudation, it will be immediately attracted to the instrument, and can be lifted through the lips of the wound. The conjunctival flap after careful sterilization of the wound as already described, is stitched into place, and the remainder of the treatment consists in that recommended after wounds of the cornea-scleral junction. If the body has been for some time within the globe, it may be necessary to make several attempts before securing it, shift-

ing slightly the extension point to vary the line of direction of the pull of the magnet. (2) Magnet extraction with a giant magnet (large Lancaster model or Haab magnet), in such a manner that the body is drawn from its position within the eye, around the lens, into the anterior chamber, from which it is removed with a small hand magnet through a corneal incision, preferably made above (indirect extraction or anterior route). For this purpose, if the body is a small or comparatively small one, the center of the cornea is placed exactly opposite the extension point of the magnet; it may immediately respond, as may be seen by the bulging of the iris, from beneath which it may be drawn by altering the direction of the magnet in order to make the necessary lateral pull, after which it is moved as before mentioned. If a large body is suspected, the pole of the magnet should be allowed at first to act at some distance from the eye.

While direct removal of the foreign body is strongly advocated by many experienced surgeons, it would seem, especially in military ophthalmic surgery, and based on the experience of the western front, that the difficulties of securing prompt X-ray examination, etc., make it advisable in most instances as promptly as possible to use the anterior route and a powerful magnet.

First aid in injured eyes.—Many eye injuries, wounds of the globe, etc., occur at long distances from surgical aid in the hospital, and "first aid" should be administered as promptly as possible. As infection comes quickly from the surrounding tissues, the surface and margins of the lids and eyelashes, should be speedily cleansed with soap and water, any evident foreign material lifted from the conjunctival sac, or be flushed out, and a bandage over a compress soaked in boric acid lotion or a dry one, should be applied. This is possible if a first-aid packet is at hand. If such a packet can not be secured, the lids and lashes should be washed with clean water, to which may be added (a teaspoonful to a pint) common salt. Alcohol is usually available, and may be used to cleanse the surface of the lids and the surrounding skin. It must not enter the eye. Handkerchiefs, so often used for temporary bandages, are not advisable unless entirely clean, as saliva and nasal discharge are apt to be loaded with pneumococci.

Sympathetic ophthalmia—Sympathetic ophthalmitis or uveitis.—This term is applied to an inflammation of the uveal tract (iris, ciliary body and choroid) of one eye, due to the effects of a similar inflammation of the other eye.

Cause.—The most usual lesions which produce this affection are wounds in the ciliary region, passing through "the danger zone," about one-fourth of an inch wide, surrounding the cornea, beneath

which lies the ciliary body, followed by an infective iridocyclitis; retained foreign bodies within the globe, which have created an iridocyclitis; perforating wounds or ulcers, with prolapse and incarceration of the iris, or scars involving the ciliary body. It occurs more commonly in children and young persons than in those of maturer years, but no age of life is exempt. The eye primarily thus injured is called the "exciting eye"; the fellow eye, to which the inflammation is transferred, is called the sympathizing eye.

There is no general agreement among investigators in regard to the pathogenesis of this affection. It probably should be regarded as a *metastatic* infection proceeding by way of the blood streams, due to some form of micro-organism which is pathogenic for the eye alone, and which has not yet been isolated. The pathologic anatomy of the originally affected eye is practically characteristic, and is a form of proliferating uveitis affecting the iris, ciliary body, and choroid. The same conditions are present in the exciting and sympathizing eye.

Period of incubation and symptoms.—The period of time between the injury of the exciting eye and the development of the inflammation of the sympathizing eye is usually from three to six weeks. Exceptionally it occurs at an earlier date, two weeks, and it may rarely be delayed for a long time.

Frequently the inflammation in the sympathizing eye begins insidiously, sometimes after a period of irritation, so-called sympathetic irritation. Certain danger signals in the eye about to be sympathetically affected are these: Failure of accommodation, contraction of the visual field—so-called fatigue field—and a spot of tenderness in the upper ciliary region, corresponding to a similar spot in the injured eye.

With or without warning the inflammation begins, and assumes usually the appearance of an iridocyclitis, with much plastic exudation and synechia, going on to involvement of the choroid, degeneration of the vitreous, opacity of the lens and shrinking of the eyeball. In other cases the appearances are those of a uveitis, with many deposits on the posterior surface of the cornea (punctate keratitis), discoloration of the iris, comparatively few synechiae, rise of tension, and involvement of the choroid.

Prognosis.—This is always most grave; exceptionally recovery occurs under the influence of vigorous treatment. In the present war, according to English investigations, the incidence of sympathetic ophthalmia has been far lower than that, for example, in our Civil War. In recent years the severity of this ophthalmitis has apparently declined, as well as its frequency, probably due to improved methods of treating injured eyes.

Treatment.—The approved treatment of injured eyes has been referred to on page 70. Should the disease develop, the affected eyes should be treated with atropin, as in all cases of iritis, unless there is rise of tension. Mercury internally, or by inunction, is usually advocated and should be tried, but the remedy which does the most good is salicylate of sodium in very large doses, as much as 1 grain (0.065 gm.) of this drug daily for each pound of body weight. As these large doses can not always be borne, 60–100 grains (3.9–6.5 gm.) per diem may be given. In place of the salicylate, aspirin may be employed in very large doses. Salvarsan and neosalvarsan have been used with good effect. Other drugs which have been recommended are atophan (40–60 grains or 2.6–3.9 gm. daily), and benzosalin in full doses.

Prophylaxis.—This comprises (1) the treatment of the eye originally injured (p. 71), and *preventive enucleation.* In general terms, the surgeon should enucleate:

1. An eye with a wound so situated as to involve the ciliary region, and so extensive as to destroy sight immediately or to make its ultimate destruction by inflammation of the iris and ciliary body reasonably certain.

2. An eye with a wound in this region already complicated by severe inflammation of the iris or ciliary body, even if sight is not destroyed; or an eye containing a foreign body which judicious efforts have failed to extract, and in which severe iritis is present, even if sight is not destroyed.

3. An eye the vision of which has been destroyed by plastic iridocyclitis, or one which has atrophied or shrunken, provided there are tenderness on pressure in the ciliary region and attacks of recurring irritation; or without waiting for signs of irritation.

4. An eye the sight of which has been destroyed, even though sympathetic inflammation has begun in the sympathizing eye, in the hope of removing a source of irritation, and thus rendering treatment to the second eye more effectual.

5. An eye in which the wound has involved the cornea, iris, or ciliary region, either with or without injury to the lens, and in which persistent sympathetic irritation in the fellow eye has occurred, or in which there have been repeated relapses of sympathetic irritation.

6. An eye either primarily lost by injury or in a state of atrophy, associated with signs of sympathetic irritation in the fellow eye.

Sympathetic irritation.—This condition, although believed by some observers to represent a mild form of the disease just described and to be due to a small or intermittent dose of the toxin, should almost certainly be regarded as a *sympathetic neurosis.* It may be, as has been stated, a prodrome of sympathetic ophthalmia, may occur in

association with many types of injury of the eye, or be produced by minor lesions, for example, foreign bodies in the conjunctival sac, and may therefore never eventuate in a true inflammation of the sympathizing eye. The symptoms usually are photophobia, lacrimation, impaired accommodation, periods of disturbed vision, photopsia, asthenopia, and some supraorbital pain. It is promptly relieved by removal of the exciting cause, or by enucleating a blind and irritable injured eye, for example, a shrunken globe, which is subject to recurring attacks of congestion.

CHAPTER VIII.

GLAUCOMA AND CATARACT.

Glaucoma, colloquially termed "hardening of the eyes," is the name applied to a disease of various manifestations, of which, in the acute and subacute types, increased intraocular tension is the most important sign.

Pathogenesis.—Exactly how glaucoma arises has never been definitely decided. In general terms the following facts may be accepted: Normally the intraocular fluid, or lymph, probably produced in the ciliary body by a process of transudation, passes over the lens, through the pupil into the anterior chamber, and to the junction of the iris and cornea. There it filters through the meshes of the pectinate ligament, and is taken up by a circular canal called Schlemm's canal, from which it escapes into the anterior ciliary veins.

Upon the perfection of this filtration mechanism the normal intraocular pressure, equivalent to that of a column of mercury 25 mm. in height, depends, and this pressure preserves the shape and tension of the eyeball. If anything occurs to disturb this mechanism and impede or check the regular flow of the intraocular fluid, it is retained, and the excess causes rise of the pressure in the ocular chambers, to be followed, if it lasts long enough, by glaucoma.

These filtration channels may be disturbed, or obstructed, in a variety of ways, the most important of which are narrowing of the space which surrounds the lens, due to the increasing size of the lenticular bodies during advancing years; displacement of the iris so that it is crowded against the angle of the anterior chamber, which may happen slowly or rapidly; change in the composition of the intraocular fluid whereby it becomes thicker and more tenacious and less readily passes through the filter; blocking of the filtration channels by edema, exudate, etc.; sclerotic changes in the tissue of the pectinate ligament, though the spaces of which the fluid must pass, and vascular and vasomotor changes.

Causes.—There are many varieties of glaucoma, depending in part upon the rapidity with which any of these obstructive processes occurs, the two chief varieties of glaucoma being *acute glaucoma* and *chronic glaucoma.* Glaucoma is rare before the fortieth year of life;

the eye affected is usually but not always hyperopic, and certain races are especially liable to the disease—Jews, Egyptians, and Brazilian negroes. The disease may be excited in an eye predisposed to it by worry, insomnia, arteriosclerosis, gout, influenza, and trifacial neuralgia, and the strain of uncorrected or improperly corrected refractive error.

Acute glaucoma.—This type of the disease is divided into two stages:

(*a*) *The period of incubation or prodromal stage.*—Conspicuous symptoms are these: Failure of accommodation, so that if a patient between 45 and 55, for example, has difficulty in reading with his glasses, "wants stronger glasses" than are justified by his age and the state of his refraction, needs "a great deal of light to read by," he should be under suspicion and the tension of his eye carefully tested; temporary obscurations of vision, either dim vision or complete loss of sight, lasting for many minutes; attacks of foggy vision; and iridescent vision, which consists of a definite ring surrounding artificial lights, which thus become invested with a colored halo (halo vision), characterized by a dark band, followed by a concentric zone of prismatic colors, violet within and red without. The attacks of foggy vision, obscuration of vision, and this halo vision are practically pathognomonic.

(*b*) *Period of attack.*—While an attack of glaucoma may take place at any time, it begins with notable frequency during the later part of the night and is characterized by intense pain in the head and eye, nausea and vomiting, and rapid loss of vision, which is reduced to light perception, and even that may be obliterated. The lids are edematous, the conjunctiva injected and chemotic, the cornea steamy and anesthetic, the pupil semidilated, usually oval and motionless (no synechiæ), and the anterior chamber exceedingly narrow, sometimes obliterated. The rise of intraocular tension is very high and if measured with a tonometer the instrument will register 80 to 100° mm. of mercury, but the tension can be tested by palpating the globe with the finger tips, and the sclera will be hardly dimpled by the pressure and usually presents a boardlike resistance to the touch. The attack may be bilateral (rather rare), or only a few hours, or several days or weeks elapse before the second eye is affected (quite common); occasionally the fellow eye escapes the disease entirely, or some years may intervene before the second eye is involved. After an attack the symptoms may subside, or the disease may go on unchecked and the state of *absolute glaucoma* is established, in which the eyeball is stony hard, the iris atrophic, the lens cataractous, the sclera coarsely injected, the cornea opaque, and sight is entirely lost.

Diagnosis and prognosis.—It would seem in the presence of such an array of symptoms that a mistake in diagnosis should be im-

possible, and yet acute glaucoma has only too often been mistaken for "a cold in the eye," and for iritis, and atropin drops, always urgently contraindicated, have been instilled, with fatal consequences. The rise of tension, the oval fixed pupil, and the narrow and often obliterated chamber are characteristic. (For other differential diagnostic features see table on p. 62.)

Treatment.—In the majority of cases of acute glaucoma an operation—iridectomy, or one of its substitutes—is required. If the patient presents himself in the prodromal stage, the symptoms are usually quickly relieved by the instillation of eserin salicylate or sulphate, 2 grains (0.13 gm.) to the ounce (30 c. c.), whereby the pupil is contracted, and this miosis should be maintained by continuing this drug every three or four hours, and then gradually lessening the frequency of its use. As quickly as possible after the onset of an attack a 1 per cent solution of eserin solution, salicylate or sulphate, should be instilled. This may be used a drop at a time, every hour, or even every half hour, until the pupil contracts and the cornea clears, which will indicate that the tension is subsiding, or pilocarpin hydrochlorate, 5 grains (0.325 gm.) to the ounce (30 c. c.), may be similarly used, or the eserin and pilocarpin solution may be mixed, each in one-half the strength just recorded, and this is an excellent plan. Pain may be relieved by hot compresses, by instilling dionin 5 per cent, and by administering a hypodermic of morphia. A brisk purge, followed by full doses of salicylate of sodium, are of excellent service. If the attack does not yield to the miotics, a large peripheral iridectomy should be performed. Should it be impossible for any reason to make an iridectomy, temporary relief may be gained by a paracentesis of the cornea, but with all reasonable speed the formal operation should be done.

Chronic glaucoma (often called *glaucoma simplex* or *noncongestive glaucoma*).—This form of the disease materially differs from the acute type just described in that the external appearance of the eye is not far from normal, there are no congestive symptoms, and no injection of the conjunctiva, save only a slight enlargement of the perforating episcleral twigs (p. 26), and no pain, certainly no acute pain. The anterior chamber may be shallower than normal; in the early stages visual acuteness is not disturbed, and often, again in earlier stages, the finger palpation will reveal only doubtful rise in tension. Later, especially with the tonometer, a persisting rise, not necessarily high, of pressure can be noted.

Diagnostic symptoms.—After testing the visual acuteness the ophthalmoscope must be used to examine the eyeground, and it will be found that the optic nerve (nerve head or disk), instead of presenting its normal round or slightly oval surface, pinkish color and a

small cup, or only a "light spot" marking the position of the entrance and emergence of the retinal vessels, is completely excavated or cupped, greenish in color, that the cup is deep, and that the blood vessels are crowded to its edges, over which they are bent. Frequently the veins pulsate, and if the tension is high there may be true pulsation of the retinal arteries in the disk. The optic nerve head is usually surrounded by a rim of whitish color, the so-called glaucomatous halo, due to atrophy of the choroid.

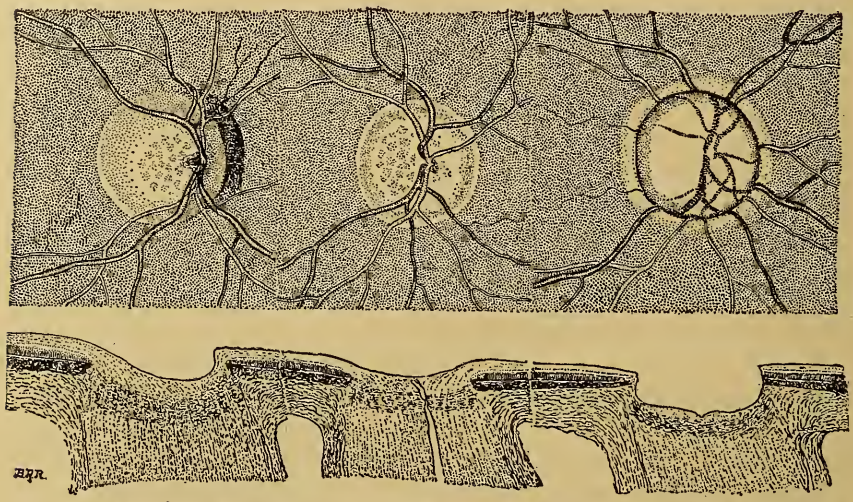

FIG. 15.—Excavations in nerve-head: 1, Physiologic; 2, atrophic; and 3, glaucomatous excavations.

The visual field in typical cases is defective on the nasal side, in the upper or lower quadrant, or the entire nasal half of the field may be wanting. Other types of contraction are also found, and in particular certain scotomas or dark areas, one being practically characteristic, which extends from the "blind spot" (the area which interprets the end of the optic nerve) and passes in an arc above and below the fixation point called Bjerrum's scotoma.

As time goes on, if the disease is not checked, the atrophy of the optic nerve advances, the visual acuteness declines, the field of vision progressively contracts, the tension increases, and blindness may ensue. At any time a chronic glaucoma may take on acute symptoms; that is, it is subject to "an attack," which, like the primary acute glaucoma, may be preceded by foggy and halo vision and acute rises of tension.

Diagnosis and prognosis.—The diagnosis depends upon the ophthalmoscopic and visual field examination and can not be made without their help. The failing vision of chronic glaucoma which usually is found only in elderly persons may be confounded with that of

cataract, especially as a greenish reflex from the lens, seen in the pupil space, is often evident, and casually examined may be regarded as an opacity of the lens, and the patient allowed to become hopelessly blind, deluded with the hope that he is waiting for the ripening of a cataract. The ophthalmoscope will at once decide the question, and examination with this instrument must never be omitted in the investigation of gradually failing vision. After repeated attacks of acute glaucoma, and during the period when the cornea is clear enough for ophthalmoscopic investigation, the same fundus changes as those seen in so-called chronic glaucoma are evident.

The *prognosis* of chronic glaucoma depends largely upon the stage of its development, and the amount of degenerative and atrophic changes. If discovered early, the process can be checked by appropriate treatment, which is practically unavailing in late stages, when the glaucomatous atrophy of the disk is advanced.

Treatment.—This should include, if operation is declined or deemed inadvisable, the persistent use of miotics, beginning with weak solutions of eserin or pilocarpin, preferably the latter, 0.1 of a grain (0.00648 gm.) to the ounce, and gradually increasing the strength to 3 grains (0.195 gm.) to the ounce, using the solution so that a persistent miosis is maintained, three or four times a day, and especially one drop in each eye at bedtime. Conjunctival irritation should be prevented by frequent irrigations with boric acid lotion, and by always using a sterile miotic solution. Massage of the eyeball with the finger tips is useful. If in spite of this the disease progresses, or if subacute attacks occur, operation should be done, and the earlier the better. Formerly iridectomy was almost always performed; in recent years many surgeons perform an operation which is designed to create a permanent filtering area—the favorite one Elliot's operation, whereby at the corneoscleral junction, and partly encroaching on the cornea a 1.5 or 2 mm. trephine opening is made, followed by a small complete iridectomy, and returning in place the conjunctival flap which had previously been dissected up to gain access to the spot to be trephined. The aqueous now flows through the trephine opening into the subconjunctival space. Lagrange's operation, whereby iridectomy is combined with sclerotomy, is also a most valuable procedure.

Secondary glaucoma, or that form which arises in consequence of some preexisting disease of the eye, may, like the primary variety, assume an acute or chronic type.

It may follow inflammation of the iris and ciliary body with the production of extensive synechiæ; serous cyclitis, ulcers of the cornea which have perforated and produced adherent cicatrices or staphylomatous bulging; swelling of the crystalline lens after needling; discission of after-cataract and, occasionally, primary extraction of

cataract; dislocation of the lens; detachment of the retina, associated with severe hemorrhage; the growth of a choroidal sarcoma or other intraocular tumor; and choroidoretinitis, plastic choroiditis, or disease of the retinal vessels. Owing to injury the vitreous may pass forward into the anterior chamber, block the channels of exit, or press against the iris, and thus cause secondary glaucoma. Adhesion of the lens capsule to the cornea following traumatism or cataract extraction not infrequently results in secondary glaucoma.

In most of the instances mentioned there is no difficulty in diagnosticating secondary glaucoma by the history of the case and the knowledge of the preexisting disease. This is not so easy if the original trouble has been deep in the eye; for example, a sarcoma. In these cases the glaucoma is usually absolute.

Treatment.—Secondary glaucoma, in general terms, requires the same treatment as the primary form of the disease, which must be modified according to the surrounding ocular conditions. A dislocated lens, or a lens swollen after discission for cataract, should be removed. Absolute glaucoma associated with great pain, if there is any suspicion of intraocular growth, indicates excision of the globe.

The most important acquired anomaly of the crystallin lens is—

Cataract.—Opacity of the lens appears in many types and under various conditions. Senile, juvenile, congenital, and traumatic cataracts are the most usual manifestations.

(*a*) **Senile cataract.**—To cataract which does not begin to develop until after the fortieth or forty-fifth year of life, but which is often delayed until the sixtieth year, the name senile is *usually* applied. As it is one of the common causes of gradual failure of vision in middle and later life, in these circumstances the lens should be carefully examined with the ophthalmoscope in the manner described on page 27. If it starts in the periphery of the lens, dark spots or streaks will be seen by reflected light, which, if examined by oblique illumination, are white or gray. Sometimes the opacity begins in the center of the lens, so that its nucleus becomes hazy and only gradually spreads to the cortex. A very frequent beginning lesion is a disk opacity in the posterior layers of the cortex, weblike in structure, or sometimes looking like a collection of minute bubbles and striæ.

Often the rate of increase in cataract formation is very slow, and immature cataract may remain unchanged for many years. At other times the development of the disease is comparatively rapid. Elderly people are often said to acquire "second sight," and this practically always means the beginning of cataract and is due to the increased refraction at the nucleus of the lens, which causes a myopia, and therefore, although distant vision is improved by concave lenses, reading becomes possible with the aid of convex lenses.

In some patients the period of this prodromal myopia is a very long one.

Senile cataract belongs to a period of mature years, but it can not be regarded as a physiologic attribute of old age. Although age is an important factor in its development, it must be regarded only as a predisposing cause. Not infrequently sugar is found in the urine of patients with cataractous lenses, and there is one type of cataract of somewhat characteristic formation which may be truly called a diabetic cataract. Certain occupations predispose to the formation of lenticular opacities, particularly among men who are exposed to high degrees of radiated heat—for example, glass blowers and furnace workers. Occasionally there are remarkable examples of the influence of heredity in the formation of cataract, the transmission generally being through the female line. These types of so-called *inherited cataract* are a special variety, in one sense of the word; in other words, ordinary senile cataract does not belong to this category, although patients frequently dread the onset of cataract because they know that their parents have been afflicted.

When a senile cataract becomes *ripe*, or *mature*, the whole lens is thoroughly opaque, and even without a dilated pupil can be readily seen, as it is usually gray, sometimes white, in color, but it is not possible to determine satisfactorily whether all portions of the lens are opaque or not without examining the periphery of the lens through a dilated pupil, and it is important that this examination should thus be made because sometimes only the center of the lens is quite opaque, and patients are sent long distances for the removal of cataract when really it is not ready for operative interference, because the outlying portions of the lens have been covered with the iris and can not be seen until the pupil is dilated.

Although operation is usually deferred until the cataract is ripe, unripe cataracts can be extracted quite readily after the sixtieth year of life, and at earlier periods of life if the operation of extraction within the capsule of the lens is considered.

In order to ascertain whether a cataract is ready for operation or not, after dilatation of the pupil an examination both by oblique illumination and by reflected light with the ophthalmoscope is made. If the lens is thoroughly opaque no red reflex will be transmitted from the fundus. The patient should be placed before a lighted candle about 4 mm. distant, and he should be able to recognize the light distinctly. If he can not recognize the light, it would indicate that there is disease of the fundus of the eye which would vitiate the result of operative interference. Next, the eye under examination should fix the flame attentively, and the surgeon should move a second lighted candle radially through the field of vision. If the eye is in good condition behind the cataract, the flame should be

recognized as soon as the rays strike the edge of the cornea, and the patient should be able to indicate the direction from which it is coming.

Treatment.—Much has been written about various drugs which are supposed to dissolve a growing cataract. They do not exist, and it is doubtful if any of the methods which have been advocated to check the advancement of cataract are really satisfactory. For example, it has been recommended to use subconjunctival injections of cyanid of mercury 1–4,000, but there does not seem to be any good evidence that this is an efficient technic, at least sufficiently efficient to warrant the very decided pain which these injections are apt to give. The internal administration of the iodids is advised, and doubtless they may do good in the sense that they improve the nutrition of the choroid, and in that respect, perhaps, have a deterrent influence on the cataractous development. The instillation of a 1 per cent solution of iodid of sodium, followed by light massage of the eye, is also advocated by many surgeons. As soon as the cataract is sufficiently ripe to warrant it, and always the eye being in good condition when it is ripe, the lens should be extracted by one or other of the well-known methods of cataract operation.

(*b*) **Juvenile cataract** is a term descriptive of those opacities which occur before the fortieth year of life. They are also called *presenile cataracts*. Sometimes they exist as evidence of the influence of heredity; sometimes they arise without known cause; and sometimes they are the results of changes in the deeper portion of the uveal tract which have destroyed or vitiated the nutrition of the lens. These cataracts should also be extracted when they are ripe. If they are soft, that is to say, if the center or nucleus of the lens is not hard, the extraction can be performed by what is known as the *linear method*, the same method which is suited to the removal of traumatic types of cataract.

(*c*) **Congenital cataract.**—This may appear as a complete or partial opacity of the lens, the most usual variety of partial congenital cataract being the so-called *zonular* or *lamellar cataract*, which, as its name implies, appears in the form of an opaque layer surrounding the nearly clear center of the lens. Through the dilated pupil, and examined with the ophthalmic mirror, this central zone appears to be dark, and is surrounded by a reddish circle due to the reflection from the fundus passing through the peripheral portions of the zone.

Exactly what causes lamellar cataract is unknown. It may be due to a developmental effect. Many of its subjects are rachitic, and often the history of convulsions in childhood can be obtained. These congenital cataracts are noted at birth, and are treated perfectly properly by operative measures after the tenth month of life. The operation usually performed is the so-called *needle operation*, whereby the cata-

ract is broken up in successive operative periods by the insertion of a needle and opening the capsule of the lens, so that the aqueous may come in contact with the lens tissue and cause its absorption.

Occasionally from the very beginning a congenital cataract is entirely opaque, the children with such cataracts being "born blind," as the saying is. The eyes may be healthy in other respects, or there may be changes in the choroid, retina, and optic nerves, and congenital faults of development of the eye. Such cataracts, too, should be treated by the operative measures just described.

(*d*) **Traumatic cataract.**—This form of cataract is caused by direct injury to the lens by some penetrating substance which lacerates the capsule and permits the entrance of aqueous humor (see p. 70). The lens substance swells up, becomes opaque, and some of it may escape into the anterior chamber. Not infrequently in the development of cataract of this type there may be an associated iritis, and secondary glaucoma, because of the swelling of the lens, is not uncommon. When the cataract is opaque it can be extracted, either in the ordinary method or by linear extraction.

CHAPTER IX.

COMMON MANIFESTATIONS OF SYPHILIS AND TUBERCULOSIS OF THE EYE.

The influence of syphilis and tuberculosis on the eye and its appendages is widespread, and none of the ocular tissues is immune, some of them, especially those of the uveal tract (iris, ciliary body, and choroid) being peculiarly sensitive to these infections. For convenience of reference the commoner affections of the eye in this regard are grouped in one chapter.

Syphilis of the eyelids and conjunctiva.—Although a chancre of the lids, usually found in the area included by the lid borders and the canthus, is an uncommon affection, it is included here because it has most often been communicated by the application of the lips or tongue of an individual with mucous patches in the mouth, as, for instance, by the filthy practice of attempting to remove a foreign body with the tip of the tongue, or endeavoring to suck out extravasated blood (p. 29). The lesion, which is a saucer-shaped ulceration with indurated base, somewhat resembles a broken-down stye or ruptured chalazion with granulating edges. A Wassermann test, or a search in the secretion for spirochete pallida, will decide the diagnosis.

Otherwise unexplained small nodules in the skin of the eyelid and indrawn scars in the region of the upper lid beneath the arch of the brow formed by the cicatrization of an ulcerated gumma of this region should always suggest syphilis. The lesions of secondary syphilis upon the eyelids require no special description, and, excepting the occasional formation of mucous patches on the conjunctiva, specific lesions of this membrane are very rare. Sometimes the tarsus is greatly thickened in syphilis (*syphilitic tarsitis*).

Syphilis of the cornea.—The most important of the specific corneal affections is *parenchymatous* or *interstitial keratitis*, a diffuse form of keratitis, without ulceration.

Causes.—It manifests itself in two forms from the etiologic standpoint: (*a*) *Inherited syphilitic parenchymatous keratitis*, and *acquired syphilitic parenchymatous keratitis.*

Sixty per cent of the cases depend upon inherited syphilis, and the disease begins most frequently between the ages of 5 and 15, and is more common among girls than boys.

Symptoms.—After a few days of slight ciliary congestion and watering of the eyes, spots of haziness appear in the cornea, either at its center or near the margin, which, carefully examined by oblique illumination, will be found to be in the parenchyma of the cornea. In a couple of weeks they spread until nearly the whole cornea becomes diffusely hazy, has a steamy surface, and somewhat resembles the appearance of ground glass. Soon blood vessels are thickly set in the layers of the cornea, especially above, and give it in their region a somewhat salmon color—the so-called "salmon patch of Hutchinson." The disease is almost always complicated with iritis and iridocyclitis, the tension may rise, and secondary glaucoma occur. After the cornea is clear enough to permit the examination, the ophthalmoscope will reveal areas of choroiditis, especially in the anterior part of the eye ground. The subjects of this disease often present in marked degree other stigmata of syphilis: Dwarfed stature, coarse skin, sunken nasal bridge, scars at the angle of the mouth and nose, rhagades, and malformed permanent teeth, with the central incisors vertically notched (Hutchinson's teeth).

Diagnosis and prognosis.—The symptoms described are quite characteristic, but a Wassermann test should be made to be sure of the character of the infection. The finding of minute straight vessel channels, not confined to cicatrices, in a cornea, and with the history of inflammation in childhood should lead the examiner to suspect syphilis. In estimating a prognosis these facts must be remembered:

From 6 to 18 months are usually consumed in the development of the various stages of the disease. The second eye is almost certain to be attacked in from a few weeks to two months; even active medication may not prevent the involvement of the second eye. In rare instances the interval is many months, even a year; it may be delayed from five to six years. The patient or his friends must be warned of this fact.

A return to perfect transparency is unusual. The vessel formation in the cornea probably never subsides entirely, but even long-continued opacity in the course of time may markedly lessen, and reasonable vision be restored. The occasional onset of deep-seated inflammation of the ciliary region, and the fact that after the cornea has cleared evidences of former choroiditis, retinitis, or disease of the optic disk, with glaucomatous cupping, may be discovered, must not be forgotten in rendering a prognosis.

Treatment.—All irritating applications are harmful. Atropin, to maintain mydriasis, prevent iritis, and allay inflammation, should be systematically employed, unless rise of tension appears, when it must

be discontinued. Dionin is of distinct service. The frequent use of hot fomentations is useful, and tenderness in the ciliary region will be relieved by a leech applied to the temple. The eyes may be protected from dust and light by goggles or a dark shade.

The constitutional treatment for syphilis is absolutely necessary, which is described on page 63. In addition to this, or following it, arsenic, iron, and bichlorid of mercury are useful remedies. In the later stages, after all irritation has subsided, massage with the salve of the yellow oxid of mercury is useful in that it facilitates the clearing of the cornea.

Two to 10 per cent of the cases of this type of keratitis are due to *acquired syphilis*, and appear usually in the late secondary or tertiary period of the constitutional disease. Unlike the inherited form of the disease, interstitial keratitis from acquired syphilis is usually a unilateral affection, is relatively more rapid in its evolution, and responds more promptly to treatment. Usually it appears between the twentieth and fiftieth year of life. The treatment does not differ from that of the inherited form of the affection.

Syphilis of the iris (syphilitic iritis).—Among all cases of iritis syphilis has been found to be the cause in from 30 to 60 per cent. The advent of the ocular affection may be from six weeks to eighteen months after the initial lesion; occasionally it arises during the late (tertiary) manifestations. The lesions are due to the lodgment and activities of the spirochete pallida, which in these circumstances has been found in the aqueous humor.

Clinical varieties of syphilitic iritis.—The clinical manifestations of this type of iritis vary, and may be grouped as follows:

(*a*) **Acute syphilitic iritis.**—In this form the usual signs of iritis are present—pericorneal injection, firm, broad posterior synechiæ, exudation in the pupil space, and localized discolored swellings in the edematous iris tissue. In other words, there are no lesions in the inflamed iris which of themselves would justify the diagnosis of syphilis, which must be established by the history and the results of the serum reaction of Wassermann. This form of iritis may be one that arises during the earlier periods of the disease.

(*b*) **True syphilitic iritis (iritis papulosa, syphilitic parenchymatous iritis).**—This form of iritis is characterized by the formation of localized sphincter lesions or papules, which are practically characteristic. In the inflamed iris there appear one

Fig. 16.—True syphilitic iritis with large nodes in iris; about seventh month of the disease.

or more yellowish, reddish-yellow, or reddish-brown nodules, which vary in size from a small seed to that of a small pea. Almost always these papules are situated at the pupillary or ciliary border of the iris; they vary in number from one to four, and belong to a comparatively early period of syphilis. Other signs of iritis, synechiæ, pericorneal injection, etc., are present. Sometimes before the papules form bright red loops of capillaries in the iris are visible, a form of iris roseola, which may later be the forerunner of these nodules.

(*c*) **Gummatous iritis.**—This is really a manifestation of gumma, almost always to be found at the ciliary border as a solitary lesion, a yellowish-white growth which may attain the size of a pea or small nut. Its tendency is to go toward the ciliary border. It is an uncommon manifestation of syphilis and belongs to a late (tertiary) period of the disease.

In the first two types of syphilitic iritis both eyes are attacked, usually one a little later than the other. The course is generally an acute one, and all the subjective symptoms described on page 62 are apt to be present. The condition, once thoroughly cured, rarely relapses, although the course of the disease may be a prolonged one.

Syphilis is also the cause of other manifestations of inflammation of the uveal tract, particularly that type which is characterized by a deep anterior chamber, comparatively soft synechiae, and many dots on the posterior surface of the cornea (descemetitis) and vitreous infiltration, which is known as *uveitis*.

Treatment.—The local treatment of specific iritis does not differ from that already described in connection with nonsyphilitic inflammation of the iris (see p. 63), persistent mydriasis being the important indication, preferably maintained with atropin drops (1 per cent solution). The usual *constitutional treatment* is some form of mercury, either the protiodid, blue mass, or calomel, given, as in syphilis generally, just short of the point of salivation, and continued for many weeks even after all acute symptoms have subsided. Inunctions of unguentum hydrargyrum are advantageously employed, preceded by a hot bath or diaphoresis with the aid of a hot chamber. If inunctions are properly given they represent a most satisfactory method of administering mercury, and usually 1 dram (3.9 gm.) of the ointment may be daily rubbed into the skin, Hypodermic or, rather, intramuscular injections of mercury, particularly mercuric chloride or salicylate of mercury (of mercuric chloride the dose may be from one-sixteenth to one-eighth grain—0.00405–0.008 gm.; of salicylate of mercury, one-half grain—0.0324 gm.), are strongly advocated by some surgeons.

In syphilitic iritis salvarsan produces the most favorable results, and under its influence the lesions disappear with astonishing rapidity. If the Wassermann test is positive, other things being equal, a dose

of 0.6 gram should be given intravenously (in women 0.4 gram is usually sufficient). At the expiration of three weeks, the Wassermann test being still positive, this dose may be repeated. During the intervals mercury or iodid of potassium should be administered.

Clinical trial of neosalvarsan indicates that it equals salvarsan in efficiency and that it is less toxic. In arsenic content 0.6 gram of salvarsan is equivalent to 0.9 gram of neosalvarsan. The injections may be given at comparatively frequent intervals, the dose being regulated according to circumstances and effects, as often as once in 10 days or two weeks.

There is no reason to believe that the salvarsan now being made in several laboratories in this country is not equal to the foreign article in therapeutic efficiency. Cacodylate of sodium hypodermatically has been recommended, intramuscular injections of 1–4 grains (0.06–0.26 gm.) every fourth day.

Syphilis of the choroid.—In a large percentage of the cases of choroiditis, diffuse or disseminated, syphilis is the cause, and the disease usually appears from six months to two years after the primary infection; occasionally it is postponed to the tertiary period.

(*a*) **Disseminated choroiditis.**—After a period of circumscribed greenish-gray exudation, numerous round, oval, and irregular spots are formed, surrounded completely or partly by black margins, and often dots of pigment in the center of the white area. Sometimes the lesions resemble punched-out spots, as if the tissue down to the sclera had been cut out with a sharp instrument. They are usually first found in the periphery, but gradually approach the center of the eye-ground; they may be numerous, or only one or two may be visible. The vitreous usually contains opacities, and in severe cases there may be pigmentation of the retina and atrophy of the optic nerve.

FIG. 17.—Disseminated choroiditis.

(*b*) **Diffuse choroiditis**—After a period of diffuse grayish exudation, which later undergoes absorption, the ophthalmoscope reveals large areas of exposed sclera, separated from each other by zones of apparently normal choroid, with pigment scattered over these areas and irregularly fringing their borders. The lesions for the most part lie in a plane beneath the retinal vessels.

The usual antisyphilitic treatment is required. The eyes should be protected with dark glasses if glare is painful, and the patient abstain from eye work as much as possible. If the lesions avoid the macula, vision may not be greatly disturbed, unless the optic nerve is involved; if a patch of choroiditis attack the macula, central vision is almost obliterated.

Syphilis of the retina.—A certain number of syphilitics (about 8 per cent) usually from one to two years after the primary infection, occasionally as early as the sixth month, acquire a stubborn form of retinitis or more accurately, chorio-retinitis, which is subject to relapses.

Symptoms.—Examined with the opthalmoscope, the following conditions are visible: Dustlike opacity of the vitreous; loss of transparency of the retina, rather dimly seen through the vitreous cloud; the optic nerve-head is discolored, and gives the impression of yellowish-red, oval, or round body seen through a covering fog; gray opacities line the vessels, and numerous yellowish or white spots bounded by pigment are visible in the periphery of the retina, and often collections of white spots in the macula. Vision is greatly depreciated, the field of vision contracted, and contains dark areas (scotomas). Night-blindness is usually a conspicuous symptom.

Treatment.—Vigorous antisyphilitic treatment as before detailed may yield favorable results, but often, especially if treatment has been delayed, the ultimate results are unfavorable, owing to atrophy of the optic nerve and extensive choroiditis.

Many other lesions in the retina and retinal vessels are due to syphilis; for example, streaks of opacity along the vascular channels (*specific endarteritis*), areas of edema in the macular region, associated with yellow spots and pigment dots (*macular retinitis*), and sometimes small thrombi in the vessels due to endarteritis, which may be associated with hemorrhages, although these are comparatively rare. The point is that all retinal lesions, unless the cause other than syphilis is definitely known, should be suspected, and the Wassermann test should be made.

Syphilis of the exterior eye muscles.—The effect of syphilis on the exterior ocular muscles has been referred to on page 15, and it is estimated that about one-half of the palsies of these muscles is due to specific infection. The paralysis may be due to an inflammation, or gummatous process, which affects the nerve supply of these muscles at the base of the brain, or in the orbit, or it may be due to disease of the nuclei of the nerves or of the brain in their vicinity, or to lesions in the aqueduct of Sylvius, or the fourth ventricle.

Generally ocular muscle palsy is a late manifestation of syphilis, and the muscle affected and the character of the diplopia are determined according to the descriptions on page 16, but occasionally

such paralyses have been noted as early as the sixth month after the primary infection, particularly in the form of ptosis, which may be transient. Among the parasyphilitic disorders palsies of the eye muscles, often transitory in nature, and usually associated with characteristic pupil changes (p. 22), are frequent in locomotor ataxia and paretic dementia. Evidently diplopia must always strongly indicate not only a most thorough examination of the eyes but of the general system, to include a Wassermann test of the blood.

Treatment.—Syphilitic ocular muscle palsy is not as favorably influenced by salvarsan and neosalvarsan as specific disease of the uveal tract. Mercury should be administered in the usual manner, and very large, ascending doses of iodid of potassium are usually of great advantage. To overcome the annoyance of double vision the affected eye may be excluded from the visual act by covering it with an eye shade or, if the patient wears spectacles, inserting a ground glass in the frame on the side of the involved eye.

Tuberculosis of the conjunctiva.—This may be a primary or secondary affection of rare occurrence, and is mentioned here because it has sometimes been mistaken for trachoma. It usually appears in the form of caseating conjunctival ulcers or grayish subconjunctival nodules—the type which somewhat resembles trachoma—or of sago-grain follicles, or tumid, hypertrophied papillæ, which suggest the papillary types of trachoma. In any doubtful case the excised tissue should be examined histologically and bacteriologically, and a tuberculin test should be made. Should the tissue prove to be tuberculous, injections of tuberculin T. R. may be tried, and applications of 50 per cent strength of lactic acid are said to be efficacious.

Tuberculosis of the cornea.—Reference to the relation which exists between tuberculosis and phlyctenular keratitis has been made (p. 53). In addition to this there are two definite varieties of tuberculous keratitis:

(*a*) **Parenchymatous interstitial keratitis,** presenting symptoms similar to the syphilitic variety of the disease, already described on page 59. Indeed, next to syphilis, tuberculosis is responsible for the development, certainly in children, of the greater number of these cases, being the etiologic factor in at least 10 per cent of them. The diagnosis must rest largely upon the results of laboratory tests (Wassermann tests; t. b. diagnostic tuberculin injections).

(*b*) **Sclero-keratitis.**—This affection is not an uncommon one, and is seen in adults, as well as in children, who may or may not have a tuberculous focus elsewhere in the body, for example, in the lymph glands of the neck. Usually a number of small, grayish nodules develop in the episscleral tissues, and in the adjacent cornea a triangular infiltrate appears, its base at the corneal periphery. Associated symptoms are ciliary congestion and sometimes iritis. In-

deed, in most of the tuberculous forms of keratitis the origin of the disease is in the uveal tract, from which it extends into the cornea, or the infection arising in the filtering angle may be conveyed by the aqueous humor.

Tuberculosis of the uveal tract (iris, ciliary body, choroid).

(*a*) **Tuberculous iritis.**—A form of iritis, usually between the fifth and twenty-fifth year of life, has been described, which is characterized by the development at the margin of the pupil, or at its ciliary border, of grayish-red or yellowish nodules. The iris may be inflamed, synechiæ form, and dots are deposited on the posterior surface of the cornea. In many respects this affection resembles true syphilitic iritis (iritis papulosa, p. 92), although the nodules differ in size and somewhat in color. For diagnostic purposes Koch's old tuberculin may be used in gradually increasing doses, beginning with 1 mg., and with two-day intervals increasing to 5 mg., watching for a local or a general reaction.

(*b*) **Tuberculous irido-cyclitis (uveitis).**—This affection, which has several times been referred to as having as its cause any of the infections and systemic diseases which are responsible for various forms of iritis, is frequently due to tuberculosis, especially its chronic variety.

The anterior chamber is deeper than normal, the cornea and aqueous hazy, and there is a precipitate of opaque dots on the posterior surface of the cornea, generally arranged in a triangular manner, the apex pointing upward. Sometimes the dots are small and almost dust-like. sometimes larger and drop-like, and have been called "mutton-fat drops" because of their color and greasy appearance. Synechiae are not conspicuous, vitreous opacities are common, and there is moderate ciliary congestion. Rises of intraocular tension (tendency to secondary glaucoma) are frequent. The prognosis is grave, but vigorous treatment may secure satisfactory results. The disease may occur at any age, but is most common in young adults, and more frequent in women than in men.

Tuberculosis of the choroid.—The description of the lesions found in the choroid in syphilis (p. 93) apply equally well in many of their manifestations to those which arise, either in the disseminated or diffuse variety, under the influence of tuberculosis. Formerly almost all of these fundus changes were attributed to syphilis, but now it is well known that a good many of them are caused by tuberculous infection. The patients may have foci of tuberculosis elsewhere in the body, or the ocular disease may develop independently of these, at least in the absence of their definite demonstration. Associated with tuberculous meningitis, tubercles may be found in the choroid, sometimes very small lesions (tuberculous dust), or as definite yellowish-white areas, surrounded by an ill-defined rose-colored area.

Treatment.—The various forms of tuberculous keratitis, iritis, and uveitis require locally atropin drops to control inflammation—in short, the local treatment of ordinary iritis and keratitis already described, unless the tension rises. The dietetic and climatic treatment suited to tuberculosis is important, and tuberculin injections are often of distinct advantage, used as follows: *Using tuberculin* T. R., the treatment begins with the dose of one five-hundredth mg., and gradually increases to one-fiftieth mg., and even to ten-fiftieths mg. In some cases the dose is further increased from one-fifth mg. to five-fifths; i. e., 1 mg. by one-fifth mg. at each injection. A bouillion filtrate of tuberculin obtained from the Saranac Laboratory, with the initial dose of 0.0001 mg., is useful. Tuberculin "Old" may be used as follows: The five dilutions contain respectively 1–1,000 mg., 1–100 mg., 1–10 mg., 1 mg., and 10 mg. The dose of each dilution is 2 mg., and is progressively increased until 20 minims are injected. Following this, the next series is begun.

During the treatment the lesions must be carefully watched lest excessive reaction occur, a consequence which is to be avoided, in fact, the best results are obtained if the doses of tuberculin are so regulated that reaction does not occur, or at least, only in mild degree.

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CHAPTER X.

DISEASES OF THE ORBIT.

Among the general symptoms of orbital disease two are conspicuous—*proptosis*, or *exophthalmos*, that is, more or less protrusion and displacement of the globe, and *immobility of the eyeball*, that is, a partial or complete loss of the rotations of the globe. Additional symptoms may be chemosis of the conjunctiva, edema, redness and swelling of the eyelids; pain and tenderness on pressure along the orbital margin; deep fluctuation, especially in abscess, and visual disturbance.

Exophthalmos and its significance.—Conspicuous as exophthalmos is in orbital disease, there are other causes of this condition, and for convenience of reference the important various lesions of all types which produce proptosis, exclusively of congenital faults, may be grouped as follows:

(*a*) **Orbital causes** include: Hemorrhage, the result of fracture or wounds, more rarely in grave anemia, scurvy, and arteriosclerosis; emphysema, associated with, and indicative of, fracture which opens the ethmoid sinus; tumors, cysts, and aneurysm, and if the tumor is within the cone of the recti muscles, the protrusion is apt to be a forward displacement, while if situated outside of the cone, the globe is displaced in some particular direction; inflammation of the cellulofatty tissue of the orbit (cellulitis), the result of infected wounds and of inflammation of the accessory sinuses, especially the ethmoid; and periostitis of the orbit.

(*b*) **Intracranial causes** include: Tumors of the middle fossa of the skull, including aneurysm of the internal carotid artery; rupture of the internal carotid into the cavernous sinus, with its classic symptoms of proptosis (exophthalmos), pulsation, either visible or tactile; bruit, both subjective and objective; and later venous ectasia, usually at the upper or inner margin of the orbit (*pulsating exophthalmos*); and *thrombosis of the cavernous sinus*, usually caused by disease of the sphenoid sinus and pyogenic infection from the ear, with proptosis, edema of the lids, chemosis of the conjunctiva, anesthesia of the cornea, fixity of the globe due to partial or complete involvement of the third, fourth, and sixth nerves, venous engorgement of the retinal veins, and optic neuritis.

(*c*) **Systemic causes** include: Graves's disease (exophthalmic goiter) with its three cardinal symptoms—enlargement of the thyroid, tachycardia, and prominence of the eyeballs, and in addition lagging of the upper lid in downward rotation of the globe, retraction of the upper lid and widening of the palpebral fissure, and imperfect or lost power of convergence; Bright's disease, the proptosis being slight; irritation of the sympathetic in the cervical region, associated with moderately dilated pupil, widening of the fissure of the lids, and pallor of the face; and syphilitic or tuberculous periostitis, as before mentioned.

To investigate in any case of exophthalmos it is necessary to take a careful clinical history, to note the degree and direction of the displacement of the globe, to palpate accessible portions of the orbit, to determine the resistance to backward displacement of the globe, to test the mobility of the globe, to search for bruit by auscultating the eyeball and surrounding area, to search for inflammatory symptoms and the presence of fluctuation, to study the associated central and systematic conditions, to examine the eyeground ophthalmoscopically, and to make a stereoscopic X-ray examination of the head and orbital region. In all cases of prolonged exophthalmos the cornea must be carefully watched for ulceration (exposure keratitis), and to prevent such a condition the plan advised on page 58 should be adopted.

Periostitis of the orbit.—This appears in an acute or chronic form, and may be localized or diffused.

Symptoms.—In acute localized periostitis there are fever, pain, tenderness on pressure over the seat of the disease, usually the margin of the orbit, injection and chemosis of the conjunctiva and edema of the lid; sometimes moderate proptosis. An abscess, subperiosteal, may form and terminate in an orbital fistula, and caries and necrosis of the orbital arch, or of the bones of the orbital wall. The process may be chronic in nature, without material change in the symptoms described.

Causes.—Many cases are due to syphilis and represent sometimes a secondary, more often a late, manifestation of the disease. Other causes are so-called rheumatism, tuberculosis, injuries and disease of the accessory sinuses.

Treatment.—Constitutional remedies must be administered according to the systemic infection. Foci of suppuration should be evacuated, and at the proper time, according to the ordinary rules of general surgery, and diseased portions of bone should be removed.

Cellulitis of the orbit.—This affection, which is an inflammation of the cellular and fatty tissues of the orbit, may be acute or chronic.

Symptoms.—In the *acute* variety of the disease there are chills, fever, deep-seated pain, most marked upon attempting to move the

eyes, general headache, exophthalmos, limitation in the movements of the eye (which may become entirely fixed), and swelling and edema of the lids, together with hyperemia and chemosis of the conjunctiva. The last two symptoms are so severe at times as to give at first sight the general impression of a violent attack of purulent conjunctivitis.

In the earlier stages vision is not usually affected, but later there may be optic neuritis followed by atrophy, dilatation of the pupil, anesthesia, and even ulceration of the cornea, and, indeed, in severe cases, the eyeball may suppurate. Fluctuation finally develops, and pointing usually occurs below the inner portion of the supra-orbital ridge.

The symptoms of *chronic* abscess are much less violent and distinctive than those just described. They may, indeed, be mistaken for other morbid conditions, especially as the abscess is commonly associated with diseased bone or periosteum in scrofulous subjects, or may occur in them from an injury or the presence of a foreign body.

The *causes* of orbital cellulitis are various. It may be traumatic or may be due to exposure to cold; it may follow in the wake of scarlatina, typhoid fever, or influenza; or it may be the result of a meningitis. The most violent types of orbital cellulitis occur with facial erysipelas. In these instances the affection is usually double. The extension of inflammation from diseased teeth or suppuration in the ethmoid cells, sphenoid, or antrum of Highmore may cause the affection. The largest number of orbital inflammations (about 60 per cent) are due to accessory sinus inflammation. The infection is conveyed from the sinus to the orbital contents by means of septic thrombosis, thrombophlebitis, lymphangitis, or erosion of the bony partition. Finally, a certain number of cases are metastatic and develop in the course of pyemia, especially puerperal septicemia. The association of orbital cellulitis with periostitis has already been referred to, and a certain amount of cellulitis occurs whenever there is a general inflammation of the globe.

Progress and prognosis.—In mild cases the prognosis is favorable; in severe cases unfavorable; and in double cases, especially those which have originated under the influence of erysipelas, usually fatal. Although the pus may make its exit through the conjunctiva or eyelid, it may also pass backward through the sphenoid fissure. It may extend to the meninges of the brain, or to the brain and form an abscess.

Treatment.—The general treatment should include supporting measures and iron and quinin. Occasionally the pus points in the conjunctival sac and may be evacuated by an incision through the conjunctiva between the ball and the side of the orbit, care being taken not to injure the ocular muscles and to secure good drainage afterward. In deeper situations the purulent focus is best reached

by a curved incision made over the orbital ridge which divides the periosteum, which is next separated with an ordinary bone elevator, kept well between the bone and the periosteum, thus avoiding the levator, the tendon of the superior oblique, and the lacrimal gland. If pus does not immediately present, the depth of the orbit must be explored with a probe until the pocket of pus is found and evacuated by an incision through the periosteum. Drainage may be secured with iodoform gauze or an ordinary drainage-tube. The position of the original incision is determined by the probable situation of the pus; that is to say, whether it is made along the the upper, lower, inner, or outer orbital margin. If the source of the pus is from the ethmoid, the orbital plate of this bone should be perforated, carious bone and necrotic tissue removed, and a drainage tube carried from the orbit, through the ethmoid, into the nose, which not only secures an adequate drainage, but permits the subsequent washing out of the tract. Indeed, the frequent association of sinus disease with orbital cellulitis usually demands that the incision shall be so placed and sufficiently broad to render exploration of the orbital walls practicable and treatment of the affected sinus (frontal or ethmoid) possible.

CHAPTER XI.

COMMONER OPHTHALMOSCOPIC APPEARANCES.

In the section devoted to syphilis and tuberculosis of the eye brief reference was made to the usual ophthalmoscopic appearances indicative of these infections. The scope and intent of this manual do not permit any extended description of the use of the ophthalmoscope in a study of the eye ground, in short, or opthalmoscopy, but it seems advisable to add a brief account of a few of the important fundus lesions.

Normal fundus.—Viewed with the ophthalmoscope, using the direct method, the *optic nerve* appears as a nearly round or slightly oval

FIG. 18.—The normal fundus of the right eye examined by the direct method of ophthalmoscopy.

disk, situated toward the nasal side, varying in color from a grayish pink to a more decided red, the tint being most marked upon the nasal half, while the center is occupied by a whiter patch—the "light

spot"—marking the position of the entrance and emergence of the retinal vessels. The general tint of the optic disk varies with the age and complexion of the patient and with the intensity of the color of the surrounding eye ground.

The papilla is bounded by two rings. The outer one, dark colored, usually incomplete or existing only as a slight crescent of pigment upon one or the other side, is the *choroidal ring*, and represents the border of the choroidal coat, where this is pierced by the optic nerve. Within this is a faint white stripe, more distinct in elderly people, the *scleral ring*, which indicates the rim of the sclerotic coat. The choroidal ring is often imperfectly produced or entirely absent.

The central white patch may be noticeable only by contrasting it with the color of its surroundings, or it may be a distinct excavation, occupying the center of the disk, and having sharp borders, one of which often shelves slightly outward. This is the *physiologic cup*, and is the space left by the radiation of the nerve fibers toward the retina, having a floor of white color, because it is composed of the interlacing opaque fibrous tissue, or *lamina cribrosa*, which underlies the optic papilla.

From the center of the disk the principal *retinal arteries* emerge, and into it the chief *retinal veins* empty. Usually one vein and one artery pass directly upward, and one artery and one vein directly downward, and on or near the disk each divides into two branches. The arteries traverse the surface of the eye ground, dividing in numerous branches, and, passing above and below, spread over the temporal and the nasal half of the retina. Smaller branches supply the macular region, and four branches, which usually arise from the central trunks, pass outward and inward. The veins are distributed over the eye ground, and pursue the same general direction as the arteries. Each vessel presents a double contour owing to a bright stripe which passes along the center, leaving a red line on either side. This is the so-called light reflex, and is much more marked upon the arteries than upon the veins. The veins are darker colored than the arteries and are larger than these vessels in the proportion of 3 to 2. According to their situation, the vessels are named, respectively, upper and lower temporal artery and vein, upper and lower nasal artery and vein, and macular arteries and veins.

The retina is practically transparent, except in persons of dark complexion, in whom it assumes a grayish tint and streaked appearance near the nerve head.

About two disks' diameter to the outer side of the papilla and slightly below the horizontal meridian, there is a circular or slightly oval spot, equal in area to the end of the optic nerve, darker in color than the surrounding fundus, uncrossed by any visible retinal vessel,

but toward which the finer twigs of the major branches pass, fringing its boundary. This region is the *macula lutea*, or *yellow spot*, and is that portion of the eye ground concerned with the functions of direct vision.

Its center is occupied by the *foveal reflex*, which marks the edge of the *fovea centralis*, and which may appear as a spot of light, a small circle with reddish center, a shifting crescent, or a shining line. This, in turn, is surrounded by a dark area (the dark spot of the macula).

The bright glare which illuminates the pupil when the light is thrown upon it from the ophthalmoscopic mirror, and develops into the uniform red color of the fundus, when this is brought into view, arises from the *choroid*. In very fair people the imperfect development of pigment cells permits a view of the larger choroidal vessels, which resemble a mesh work of tortuous red bands with intervening spaces of lighter or darker color.

Hemorrhages in the retina.—These may be found everywhere throughout the eye ground, or grouped especially in the macular region, or around the papilla, or lying close to the retinal vessels, often in association with a thrombus in the vessel. If they lie in the fiber layer of the retina, they are usually flamed-shaped, or linear; if they are situated in the deeper layers, they are more apt to be round. They may occur independently of retinal inflammation, or in association with it (*hemorrhagic retinitis*). If the latter condition obtains, the edges of the disk are cloudy because the surrounding retina is infiltrated, and the veins are dark and tortuous. After absorption of the hemorrhages, white spots appear, indicating the position of the former blood extravasation.

FIG. 19.—Retinal hemorrhages (de Wecker and Masselon).

Causes.—The following is a classified list of the chief causes of retinal hemorrhage:

(*a*) Hemorrhages caused by changes in the composition of the blood and the tissues of the blood-vessel walls: Pyemia, septicemia, ulcerating endocarditis; diseases of the liver, spleen, kidney, and

atheroma of the vessels, and angiosclerosis of the retinal vessel; loss of blood (menorrhagia, hematemesis); anemia (simple and pernicious); hemophilia, purpura, and scurvy; diabetes and gout; tuberculosis; malaria and recurrent fever. In carcinoma of the stomach retinal hemorrhages and white spots may resemble those seen in pernicious anemia. To this manifestation the name *cachectic retinitis* is sometimes applied.

(*b*) Hemorrhages caused by disturbances in the circulation: Hypertrophy of the heart and stenosis of the valves; thrombosis of the central vein of the retina, and embolism or thrombosis of the central artery; suffocation, compression of the carotid, and hemorrhages in the new-born, which are not infrequent; and the menstrual disturbances.

(*c*) Hemorrhages caused by sudden alterations of the intra-ocular tension—e. g., after iridectomy in glaucoma—and by traumatisms. Among the latter may be classed retinal hemorrhages after large cutaneous burns, and those which have followed compression of the thorax and neck and fracture of the skull.

(*d*) Hemorrhages caused by certain toxic agents—e. g., phosphorus, chlorate of potassium, serpent virus.

Ophthalmoscopic signs of general arteriosclerosis.—Persistent high arterial tension, when this is a symptom of arteriosclerosis, is interpreted in the eye grounds by notable disturbances of its circulation. The suggestive signs include uneven character and undue tortuosity of the retinal arteries, increased distinctness of the light streak, and alterations in the course and caliber of the veins. Among the important definite or pathognomonic signs are: A beaded appearance of the retinal arteries, loss of translucency, and decided lesions in the arterial wall (*perivasculitis*), so that they may have a silvery appearance (*silver-wire arteries*), alternate contraction and dilatation of the veins and arteries, and particularly—and this is the most important of the signs—indentation of the veins by the stiffened arteries, in the same manner as a solid rod would indent a rubber tube if it pressed upon it. In addition, there may be changes in the venous walls, which are here and there bordered with white stripes, edema of the retina, especially around the disk, and retinal hemorrhages.

Such retinal vessel changes are indicative of arteriosclerosis in the vessels of the carotid circulation, and probably indicate a similar change in the smaller vessels of the brain. They are of serious prognostic import, and their subjects are liable to apoplexy of the brain, and often have chronic nephritis.

Albuminuric retinitis.—Fully 25 per cent of the patients with chronic Bright's disease, as they are examined in hospitals, are sooner or later in the course of this affection affected by one or other

of the forms of retinitis. The retinal lesions occur most frequently with chronic interstitial nephritis, but are also in association with chronic parenchymatous nephritis, with secondary contracted kid-

Fig. 20.—Changes in the fundus in arteriosclerosis.

ney, and with amyloid disease of the kidney. Nephritic retinitis is more common in men than in women.

Symptoms.—In a typical case, beginning in the macula or its immediate neighborhood, and continuing to be most numerous in this region, variously shaped and placed white spots appear. These at first may be small, discrete, and sharply separated, but later, or under other conditions; they form a somewhat *star-shaped figure*, the rays of which surround the fovea, but for the most part do not involve it. Occasionally, instead of a stellate arrangement, the white spots and lines, somewhat radially placed like spokes in a wheel, affect this neighborhood in part, but do not completely encircle it.

At some distance from the papilla, and often surrounding it, larger yellowish-white or white spots are seen, which may coalesce and form a ring-shaped zone around the nerve head broader than its own diameter. This striking, wide white area has been compared to snow, and designated "the snowbank appearance of the retina."

Other features, but, unlike the white spots, having no pathognomonic appearances, are the *hemorrhages*. They may be linear, flame shaped, or round, or mere flecks scattered here and there, and found with difficulty, or they constitute large, dark-red extravasa-

tions. Moreover, they are not constant like the white spots, but at times disappear, leaving white marks which denote their former situation. Sometimes they occur in great numbers, like fresh explosions. To a certain extent they are indications of the violence of the disease.

The blood vessels may run over the white plaques, or may be buried in the swollen retina. Sometimes a vessel disappears beneath the infiltration, to reappear at some distance beyond. The veins are dark and often tortuous; the arteries, as in other forms of retinitis, are not materially altered in size. In the later stages the vessels exhibit lack of transparency of their walls, in the form of white tissue along the sheaths, or they are actually converted into white strings.

Finally, the optic papilla and its immedate surroundings may be intensely hyperemic, or a swelling of the nerve head occurs, quite indistinguishable from that of *optic neuritis*, or *choked disk*, as it is seen in tumor of the brain. In any circumstances the edge of the papilla is clouded, but not necessarily swollen, the surrounding retina finely clouded, and traversed with numerous radiating injected lines, like those described in other types of retinitis. Quite commonly the changes in the papilla directly join the band of fatty infiltration already described, surrounding the end of the optic nerve.

There are many forms of albuminuric retinitis; in one, the so-called degenerative type, the white spots are small and the hemorrhages are small and sparsely present; the veins are dark, the arteries are sclerotic, the disk blurred, and there is no star-shaped figure in the macula.

Prognosis.—This, in so far as vision is concerned, depends upon the extent of the lesions and of the involvement of the macula. In general terms it is unfavorable, although fair vision is often retained. Sometimes the exudations practically disappear. In so far as the life of the patient is concerned, albuminuric retinitis is a most unfavorable symptom, and many patients die within two years after its detection and a considerable percentage within the first year of its development. There are, however, frequent exceptions to the rule, and the records show that patients have lived five, seven, and even a greater number of years after the retinal lesions have appeared, especially if they have been detected early and suitable treatment has been instituted.

Diabetic retinitis.—Retinitis in the course of saccharin diabetes is usually a late manifestation of the disease. Sometimes the lesions consist of widespread areas of yellowish-white exudation, often in association with hemorrhages, although also seen without such association. Opacities and hemorrhages may be found in the vitreous. Occasionally there is a special collection of small white spots and hemorrhages placed in the macular region (*central punctate diabetic retinitis*).

The vital prognosis of diabetic retinitis is grave, although not so serious as it is in albuminuric retinitis.

Detachment of the retina.—The detection of detachment of the retina with the ophthalmoscope has been referred to on page 27, as has also the method of distinguishing a single detachment from one which covers a morbid growth, for example, a sarcoma of the choroid.

Choked disk (optic neuritis).—In a number of systemic maladies and infections, and particularly in the presence of intracranial disease, notable changes occur in the optic nerve head which are described under the term "*choked disk*," or "*papilledema*," or if the condition indicates an associated inflammatory process, *optic neuritis.*

Symptoms.—In the first stages there are increased redness of the disk, with blurring of its upper and lower edges, and a gradual progression of the blurring to the nasal edge. Later the edema increases and spreads somewhat into the surrounding retina, and with this increasing edema the disk, now entirely obliterated by the swollen tissue, pushes forward in a mound-shaped elevation. The veins are dark,

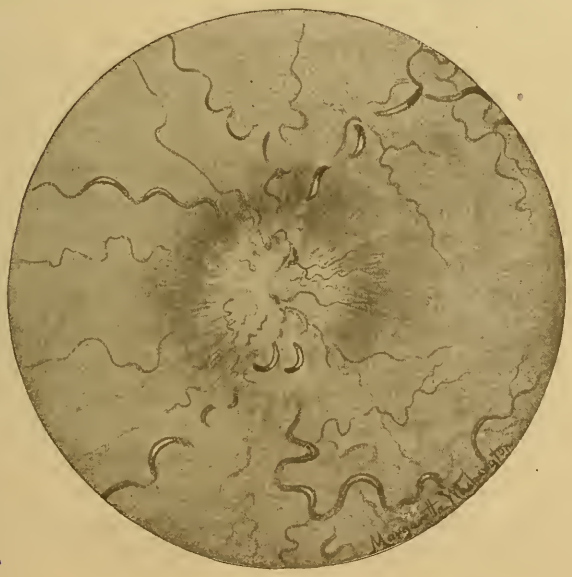

FIG. 21.—Fundus of the right eye of a patient with tumor of the brain and choked disk; swelling 6 D.

distended, and tortuous, and partly hidden in the infiltrated tissue. Many hemorrhages may be seen on or near the swollen nerve head. As time goes on the edema gradually disappears, the vascularity decreases, the disk begins to be apparent, and finally, the edges are evident and the surface of the nerve head, its center somewhat filled in, exhibits the pale color of atrophy in consequence of the choking its elements have received.

Significance of choked disk.—Double-choked disk is highly significant of the increased intracranial pressure caused by cerebral and cerebellar disease, and occurs in fully 80 per cent of the cases of brain tumor. Neoplasms of the corpora quadrigemina, of the parieto-occipital region and of the cerebellum give the highest percentage of choked disk; it is frequent in tumors of the basal ganglia. It occurs with pontine tumors if the growth attacks the neighboring tissue, and with subcortical neoplasms if they spread to the base. Tumors of the cerebellum are prone to cause a more intense form of choked disk than cerebral neoplasms; the choking is less marked in subcortical, parietal, and frontal lobe tumors. Papilledema appears in connection with cysts, epidural and subdural clots, hemorrhage after blows on the skull, causing fracture, abscess of the brain, especially from middle ear disease, and is common in meningitis, especially the tuberculous varieties, in which the appearances are suggestive of an inflammatory process in the disk (optic neuritis). Many other intracranial causes exist, for example, softening of the brain, pachymeningitis, hemorrhage, etc.

Choking of the disk is not alone due to intracranial disease or lesion. It may occur, as has been noted, in Bright's disease and angiosclerosis, and even in some forms of enemia. Certain systemic infections may cause optic neuritis, for example, influenza, syphilis, rheumatism, malaria, typhoid fever, the exanthemata, tuberculosis, etc. (*infectious optic neuritis*). As has been noted, it occurs in orbital inflammation, and not infrequently as the result of diseases of the accessory sinuses, especially the ethmoid and sphenoid.

Treatment.—Evidently the first principle of treatment depends upon ascertaining the cause and the administration of suitable remedies—mercury and the iodids in syphilis, etc. Choked disk from intracranial neoplasm is best managed by the release of the introcranial pressure by performing a cerebral decompression and, if possible at the same time, by removing the growth, but even if this is not possible the decompression often quickly causes a disappearance of the disk edema and thus saves sight. Lumbar puncture has also been employed but is not free from danger in the presence of intracranial tumor.

Many theories have been propounded to explain the pathogenesis of choked disk, the descriptions of which naturally do not find place in this manual. In general terms it is probable that choked disk is produced by a combination of factors. In this combination increased intracranial pressure or tension is most prominent, and the mechanical theory affords the most satisfactory explanation.

Optic nerve atrophy.—Atrophy of the optic nerve may be either primary or consecutive, the latter occurring, for example, after optic neuritis or severe forms of retinitis and choroiditis.

Symptoms of atrophy of the optic nerve.—In *primary atrophy* the normal pink color of the disk disappears and gives place to a gray or white color, the capillaries having disappeared. Often there is a shallow cupping of the spaces of the lamina cribrosa. The edges of the disk are distinct. According to the stage of the disease, the vessels are about normal in size or are more or less shrunken. In *consecutive atrophy* the disk, usually white or greenish-white in color, is somewhat filled in, the spaces of the lamina not being evident, and the edges of the disk are not clearly marked; the vessels are always shrunken and often streaked with white lines. Vision is always, after atrophy has existed for a period of time, much reduced, and entire blindness may be the result or, at least, only faint light perception may remain. The field of vision, especially the color field, is contracted, and this contraction begins early in the affection.

Causes.—As before noted, consecutive atrophy depends upon optic neuritis, choroiditis, and retinitis, and stoppings of the central circulation of the disk. Primary atrophy is frequent in locomotor ataxia, paretic dementia, and multiple sclerosis; less frequently in lateral sclerosis, chronic myelitis, and bulbar palsy. It has been ascribed vaguely to the influence of cold, to venereal excesses, and is often due to syphilis, the toxic action of certain drugs, excessive hemorrhage, and to arteriosclerosis and to diseases of the pituitary body.

Treatment and prognosis.—The prognosis is most unfavorable, and only too often optic nerve atrophy eventuates in practical blindness, although the course of the disease may last for months and even years. Treatment is most unsatisfactory. Naturally, in syphilitic atrophy the usual remedies may be tried; strychnia is usually prescribed, and negative galvanism has been advocated.

Orbital or retrobulbar neuritis.—In place of an edema or neuritis localized at the intraocular end of the optic nerve, the process may attack the axis of the nerve behind the eyeball—hence the name *retrobulbar* and *axial neuritis*. The ophthalmoscope reveals little or no change in the nerve head, or, at most, a slight blurring, or a pallor of its outer half.

In *acute cases* the depreciation of vision, beginning in the center, comes on rapidly and there is a large scotoma in the middle of the visual field, and there is pain on moving the eyeball and when it is pressed backward into the orbit. The usual causes are systemic infections, for example, the exanthemata, rheumatism, etc., and it may apparently arise as the result of exposure to severe cold, focal infection, especially in the teeth, tonsils, and particularly in the ethmoids, and toxic agents.

In the *chronic cases* the depreciation of vision is not so great, but in the center of the field of vision there is an area of imperfect color perception for red and green, oval in shape, which is known as a *central color scotoma.* The important cause of this affection is the abuse of alcohol and tobacco, and it is often known as *tobacco-amblyopia.* It can be caused by other toxic agents. Removal of the etiologic factor, i. e., stopping tobacco and alcohol, is usually followed by fairly prompt recovery, but the abstinence must be total. Strychnin and the other remedies mentioned in connection with optic-nerve atrophy are useful. In the acute varieties, free sweating, active purges, salicylate of sodium, and mercurials are advisable, associated with the removal of the cause—for example, a focal infection.

CHAPTER XII.

CERTAIN OCULAR DISORDERS CAUSED BY THE METHODS OF MODERN WARFARE.

As the result of recently developed methods of offense and defense a number of unusual ocular manifestations come constantly under observation during the present war. These depend upon the various uses of high explosives, upon the high velocity of the modern rifle bullet, upon the incessant and terrific fire from guns of large caliber, upon the introduction of various types of noxious and poisonous gases, and upon the unnatural conditions attending trench life and the ever-increasing duties of the aviation branch of the service.

The material for this brief and condensed summary has been derived in part from a review of the literature on this subject as it has been published in English and French journals, and in part upon accounts personally given by medical men who have served during the last two years on the western front.

The ocular phenomena of "gassing."—In the section devoted to conjunctival diseases there is a brief reference to "gas conjunctivitis," which is somewhat elaborated in the following paragraphs.

Drift-gas has been followed by more serious effects than the *shell-gas*, but both are attended with definite ocular manifestations. Drift-gas causes, in addition to great irritation of the respiratory tract, a smarting and pricking sensation of the eyes, followed by blepharospasm, photophobia, intense chemosis of the conjunctiva, and well-defined and often violent conjunctivitis.

In the majority of instances the cornea escapes, but in certain cases changes in the cornea have been noted, especially about the periphery; exceptionally a form of keratitis characterized by vesicle formation develops.

The pupils are sluggish in their reactions, and sometimes there is a change in the color of the iris. Mild degrees of neuro-retinitis have been observed with moderately dilated and tortuous veins, and a peculiar peripapillary bluish discoloration. It has been suggested that these deeper ocular changes may depend upon the irritating effects of the gas upon the mucosa of the nose and accessory sinuses. Although the actual ingredients for the production of this gas have

not been positively determined, the deleterious effects are probably due to chlorine.

Recently a virulent *shell-gas* has been introduced, which causes not only much more intense ocular manifestations, but its destructive effect is sufficient to produce burns of the skin of the second degree. Despite the severity of its action on the cutaneous surfaces, reports so far available seem to indicate that the cornea is not correspondingly affected. In the milder forms the eyes present the appearance of a slight burn, with conjunctival and ciliary injection, and with secretion that may be either watery or mucopurulent. The cornea may entirely escape, or, with the loupe, roughening of the epithelium may be noted. In severe cases corneal lesions in the form of punctate opacities or diffuse clouding may develop; the lesions usually do not take the fluorescin stain, but there may be definite ulcer formation. The prognosis is favorable.

Treatment should include those remedies which relieve the conditions of the conjunctiva which depend upon exposure to irritants, such as the use of the simpler and milder eye lotions. Zinc sulphate lotion has been a much favored remedy. An occlusive dressing should not be used, but a screen attached at the brow, or dark glasses, should be adjusted. It seems probable that holocain (2 per cent) and liquid albolene should be of service, but cocain should not be employed, except as an agent for temporary anesthesia to facilitate examination.

Ocular phenomena of shell shock.—As the result of exposure to nearby shell explosions a series of interesting symptoms have been observed, and among these is blindness, in many instances unattended by exterior or interior ocular changes. The blindness is often noted immediately after the patient has regained consciousness. In some cases the symptoms have included, in addition to an amblyopia (dull sight), contracted visual fields, slight deafness, and imperfect sense of smell and taste. The loss of vision appears to have a definite neural basis, associated with what is usually called a "functional condition" (Parsons).

The prognosis is good, but the possibility of intracranial injury as the result of concussion of the head from the fall, must be considered.

The treatment that seems to have been most effective has been suggestion, and in certain instances hypnotism. Many of the patients have done well if they were excluded from sympathy, and were given regular but simple employment. In certain other cases isolation in bed with fluid diet and deprivation of tobacco, has been of service.

The interior of the eye, however, does not always escape, and the eyes of many soldiers have been seriously injured by indirect concussion on account of their proximity to bursting shells. Such air

concussion may cause intraocular hemorrhage, "holes in the macula," ruptures of the choroid, and optic nerve atrophy.

Night blindness.—In practically all of the armies in the field a large number of cases of night blindness has been observed, and the seriousness of this condition is readily realized when consideration is given to the ground over which those affected are obliged to travel. No reference is now made to those types of night blindness which arise under the influence of hereditary transmissions, or to those which belong to the symptomatology of organic disease of the retina, but only to those cases which arise spontaneously, and can not be traced to ocular or general disease.

The patients thus described may be classified in two groups (*a*) those in whom the night blindness, or *nocturnal amblyopia*, is ascribed to the influence of uncorrected or imperfectly neutralized errors of refraction; (*b*) those in whom the night blindness has been ascribed to the unnatural character of trench life and its nocturnal activities, to insufficient diet, and to fatigue and continual nervous shock.

Treatment.—The prognosis is favorable, and the treatment should include the adjustment of proper spectacles, improvement in the diet, and the exhibition of tonics, for example, iron, strychnine, quinine, and arsenic. Some of the night-blind soldiers have not escaped the suspicion of malingering and have been detected by the examining surgeon, using his own eye as a standard, by the introduction of pieces of white paper or a luminous watch in a darkened room. Suggestion adroitly exhibited has exerted prompt and beneficial influence in some cases.

Ocular phenomena of trench nephritis.—During the present war the so-called *trench nephritis* has been frequently observed. The initial signs are dyspnoea, sore throat, and marked edema, especially of the face and the extremities. These symptoms are associated with increase in blood pressure and albuminuria. In fully 50 per cent of the cases definite alterations in the fundus may be observed. In the majority of instances these changes consist in a hyperemia of the disk, which in some instances is edematous and associated with slight edema of the retina; the retinal veins may be dilated and tortuous, with perivascular markings. Neuroretinal edema and optic neuritis have been observed and more rarely flame-shaped hemorrhages and whitish exudates may be encountered, and in a few instances massive effusion with retinal detachment has been noted. Diffuse pigmentation has been observed in the periphery of the choroid and patches of slaty discoloration in the macular region. These retinal and choroidal lesions have been attributed to the low-grade inflammation of toxic origin and the nephritis to lessened skin

elimination produced by standing for days in water-soaked clothing and often in water up to the waist (Greenwood).

Rest in bed, profound slumber, and the usual eliminative measures cause rapid disappearance of the general edema and of the usual fundus lesions.

Ocular effects of glare.—In recent years the importance of the effects of glare in its various phases has been more fully appreciated. Without referring to whether some of these lesions are dependent upon heat or upon rays of special character, it is necessary only to recall the injurious effects on the eyes observed in eclipse blindness, after exposure to short electric currents, and in sun blindness. Milder dazzling effects have also been noted after exposure to the glare from sand, water, and brightly polished surfaces; thus a scotoma is developed following the use of a microscope if the direct sunlight is reflected from the mirror.

During the present war much ocular discomfort has been observed among members of the aviation branch of the service, especially among the antiaircraft gun crews, in the form of a set of irritative symptoms which have been described as "dazzling." In some of these cases peripheral scotomas are demonstrable, usually in the lower portion of the visual field. Doubtless with the constant improvement in the glass used in protecting goggles much of the injurious effects of the irritating rays of light will be eliminated.

Wounds and injuries.—Injury to the eye or its functional integrity may be due to (1) concussion, which may be either direct or indirect; (2) penetration and perforation of the globe; (3) injury to the optic nerve; (4) intracranial lesions; and (5) infections.

The greatest number of eye injuries have resulted from shells and the various trench projectiles, such as bombs and grenades; and in over half of the eyes so injured the fragments have been of small size. These fragments may cause varying degrees of concussion lesions, may perforate the lid and lodge in or penetrate the globe, ultimately resting in the orbit. The larger fragments usually cause immediate destructive lesions.

Many injuries have resulted from particles of earth, rock, or other material thrown up as the result of shell explosions or parapet shots. The character of the ground therefore influences to a certain extent the seriousness of the wounds from these flying particles, and it is probable that at least 50 per cent of the injuries could be prevented by protecting masks or goggles. It is of the utmost importance that each man should be provided with a mask of the proper character and, moreover, be thoroughly trained in its use and become skillful in its proper adjustment.

Rifle or shrapnel bullet wounds usually produce extensive and destructive lesions of the eye and adnexa, as well as of the orbit.

Inasmuch as practically all of the antero-posteriorly directed wounds are fatal, those that come under observation are usually transverse or tangential wounds. In a definite percentage of such wounds serious intraocular changes have occurred as the result of concussion, although the path of the projectile was some distance from the globe. In shots passing through the mouth there is an added danger in that fragments of teeth may act as additional projectiles.

As the result of direct concussion, all those lesions seen in civil life in similar circumstances have been encountered, for example, traumatic mydriasis, iridodialysis, dislocation of the lens, traumatic cataract of various types, intraocular hemorrhages, retino-choroidal lesions including retinal detachment, rupture of the choroid, lesions of the disk and rupture of the globe. (See p. 71.)

At times a projectile may pass behind the globe rupturing and shattering it, or it may even expel it from the orbit. At other times the impact occurs in the malar region, or about the outer end of the eyebrow or temporal region. In these circumstances the vibrations are transmitted to the eye through the medium of the orbital tissues, the extent of the injury doubtless depending upon the force of penetration and rotation of the projectile, as well as upon the elasticity and conformation of the bone directly involved. Intraocular hemorrhage, retinal detachment, and rupture of the choroid may thus be present even where the orbit has not been directly involved.

Naturally, in the penetrating injuries of the eye caused by small fragments of shells, bombs, grenades, bullet casings, copper, and other foreign material, X-ray localization prior to operation is indicated, but experience on the western front has demonstrated that frequently this technic is not possible, owing to lack of time, and a magnet test (giant magnet or large model of Lancaster magnet) should be made, and if the foreign body is magnetic it should be extracted through the anterior route as is explained on page 75. It should be remembered that small fragments may have penetrated the eye and have left no sign of the point of entrance, and therefore the care with which the eye of each wounded soldier is investigated can not be too great. (See also p. 74.)

Injury of the optic nerve posterior to the globe may be caused by the projectile, or occur in association with fractures. This injury is followed by partial or complete blindness, and possibly hemorrhage into the sheath, but pallor of the disk is not evident until several weeks after the injury.

Injuries of the visual pathway as the result of cranial trauma may depend upon fractures of the skull, or upon bullet wounds and those made by shell fragments, the immediate cause of the ocular manifestations being due to the involvement of the brain itself—hemorrhage, meningitis, or other complications. Injuries to the occiput

may directly involve the visual centers, and lead to immediate blindness or one of the types of hemianopsia, with or without scotoma (p. 23). An immediate blindness may later develop into a hemianopsia.

The lesions which most frequently give rise to intraocular changes are gunshot wound of the vault of the skull, followed by fracture. These fractures may be fissured, grooved, or depressed; or only the inner table may be fractured, leaving the external table intact. Always in these cases ophthalmoscopic examination is imperative, as well as visual field testing, as on the results of such investigation the character of the cranial operation may depend—that is, whether there shall be immediate trephining or decompression. Choked disk (papilledema, optic neuritis) would furnish a strong indication for prompt operative interference, and the examining surgeon must be careful to search for the early signs of this condition, and not wait for fully developed nerve-head changes (see p. 109).

The experience of the present war indicates that in fractures of the vault following gunshot wounds edema of the disk is present in 60 per cent of the cases. Usually the swelling is slight, not over 2 D., and is associated with slight edema of the adjacent retina. In other cases a few white exudations (plaques) may be present. Less frequently intense choking of the disk develops, similar to that seen in brain tumor. The vision may be normal, or it may be impaired in varying degrees. Symptoms of cerebral compression are usually present, and the ocular manifestations, as a rule, promptly subside after the relief of the intracranial tension. Penetrating wounds of the skull cause ocular manifestations similar to those which have been described, shrapnel wound being especially grave owing to the size of the fragment and the presence of foreign bodies.

Infected wounds of the eye are not uncommon, the infection being conveyed by the missile, or it is communicated to the injured area from the conjunctival sac. Such infection may remain localized, and yield to treatment already detailed (pp. 70–72), or spread throughout the globe and eventuate in *panophthalmitis*, with its striking symptoms: Tense edema of the lids, purulent secretion, protrusion of the eye, often so firmly pressed against the lids that they can not be separated. In other cases, while the eyeball is completely involved, the symptoms are less violent.

Treatment.—It is safe to enucleate an eyeball in which there is suppuration if the surrounding orbital tissues are not yet involved in the process, but where the process has reached a great height, where there is purulent infiltration of the orbital tissues, and where the affection has begun posteriorly, as in some varieties of septic iridochoroiditis, the operation of enucleation is surrounded by dangers. In a certain number of cases it has been followed by meningitis. Therefore under

these conditions evisceration is preferred. But even after evisceration there may be a great accumulation of inflammatory products behind the scleral cup, and to these a vent must be given.

Evisceration is performed as follows: The speculum being introduced, the conjunctiva is loosened around the cornea; the anterior chamber is transfixed with the knife on a level with the horizontal meridian, the lower portion of the cornea separated, the flap seized with forceps, and the remainder of the cornea cut away at the corneo-scleral margin. With the evisceration scoop the contents of the globe are thoroughly and cleanly evacuated. The cavity of the globe is wiped out with sterilized cotton-wool, and all bleeding is stopped. The edges of the conjunctiva are united by means of a suture similar to the string which draws shut a tobacco pouch—a suture sometimes called the tobacco-pouch suture—or by interrupted sutures. These may include the conjunctiva alone, unless this is very much macerated, when it may be necessary to include the sclera. Sometimes it is well to suture both the sclera and the conjunctiva. The evisceration may be accomplished without sacrificing the cornea provided this membrane is not infected.

Col. Lister, of the English expeditionary force, has modified an ordinary enucleation to suit the complications of infection, in that instead of dividing the optic nerve in the usual manner behind the eyeball, he leaves attached to it a fringe of the sclera, and thus avoids opening the intervaginal space of the optic nerve and lessens the danger of conveying pathogenic material to the meninges of the brain. Ordinary *complete enucleation* may be performed as follows: The lids are held apart with a stop speculum while the surgeon divides the conjunctiva and adjacent fascia with scissors in a circle as close as possible to the margin of the cornea. This is sometimes called "circumcising the cornea." The tendons of the ocular muscles, beginning with the superior rectus, are next successively raised upon a strabismus hook and divided. The eye being made to start forward by inserting the stop speculum somewhat more deeply, the eye is drawn forward, the face of the patient being turned toward the operator, and the curved scissors are introduced on the nasal side between the severed conjunctiva and the freed eyeball, and made to follow the curve of the latter until the optic nerve is reached, where the blades are expanded and the nerve seized and cut squarely off. The attachments of the oblique muscles and the remaining tissue which may cling to the eyeball are then severed. Subsequently the conjunctival wound is closed with a few interrupted sutures.

Hemorrhage is usually not severe, and is readily controlled by pressure. After freely irrigating the socket with a bichlorid solution it may be dusted with iodoform and a full antiseptic dressing should be

applied. In place of general anesthesia, local anesthesia, by means of retrobulbar injections, is preferred by some surgeons.

In order to improve the mobility of the stump, the following procedure is useful: The conjunctiva is divided as close as possible to the corneal margin; each rectus tendon is next seized with forceps, separated from the sclera, and drawn forward to the edge of the cut conjunctiva, where it is fastened with a black silk suture. The eyeball is next enucleated in the ordinary manner, hemorrhage being checked by packing the cavity with a small wad of sterilized gauze. Finally, after removal of the packing, the edges of the conjunctiva are united with interrupted sutures, which are generally placed in a horizontal direction and which also include the capsule of Tenon. The usual dressing is applied, both eyes being bandaged for 24 hours.

Further improvement from the cosmetic standpoint is obtainable if at the conclusion of an enucleation a gold or glass ball is inserted in Tenon's capsule, after which the conjunctiva is closed over it by means of stitches.

Gunshot wounds of the neck may cause paralysis of the sympathetic nerve, which in turn may cause enophthalmos, miosis, narrowing of the palpebral fissure, hypotony, secretory, and vasomotor disturbances, although in the majority of instances this syndrome has not been complete.

Diseases of the conjunctiva and cornea.—Thus far it does not appear that conjunctival conditions specially related to conditions prevailing in the present war have arisen. Conjunctivitis due to the various organisms already mentioned (p. 39) is not uncommon; trachoma has occurred, although happily not as frequently as might have been anticipated; gonorrheal conjunctivitis has not been frequent.

One form of conjunctivitis has been observed which depends upon ipecacuhana powder, purposely introduced into the conjunctival sac in order to be relieved from military duty. The characteristics of this "ipecac conjunctivitis" are its sudden onset, usually in one eye alone, the marked irritation and swelling of the *lower* conjunctival sac, with a moderate amount of secretion. Sometimes the lids have an erysipelatous appearance, and great difficulty is experienced in opening them. After repeated applications of this drug to the conjunctiva, the membrane acquires a peculiar salmon tint, and the upper cul-de-sac may be affected, which in the acute cases practically always escapes. Corneal ulcers not differing in character from those which have been described (p. 53) have been very frequently observed.

CHAPTER XIII.

DEFINITION OF REFRACTIVE ERRORS AND THEIR DETECTION.

The emmetropic eye is the standard eye, or unit of measurement, and is known as the eye which has normal visual acuteness and a standard amount of accommodative power.

An emmetropic eye receives parallel rays of light at a focus on its retina, and likewise emits parallel rays for infinity vision. Fig. 22 represents this form of eye.

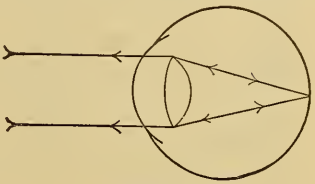

FIG. 22.

An eye that is not emmetropic is ametropic.

An ametropic eye is one which, in a state of rest, does not form a distinct image of distinct objects upon its retina; it does not focus parallel rays of light upon its fovea. There are two forms of ametropia—axial and curvature ametropia.

Axial ametropia is the condition in which the dioptric apparatus refracts equally in all meridians, but the retina of the eye, when at rest, is either closer to or farther away from the nodal point than the principal focus. (See fig. 23.)

Axial ametropia means that the refractive error or condition of the eye is measured on its antero-posterior length or axis.

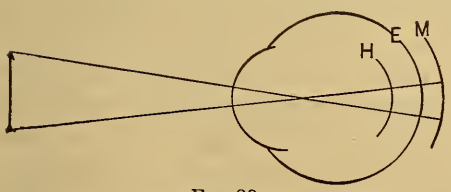

FIG. 23.

Curvature ametropia, in contradistinction to axial ametropia, is the condition in which the dioptric apparatus does not refract equally in all meridians, and with the result that there is no focusing of all the rays of light at one point; or curvature ametropia may be considered as that condition in which parallel rays of light entering an eye have two focal planes for two principal meridians, usually at right angles to each other. Curvature ametropia is commonly spoken of as *astigmatism.*

There are two forms of axial ametropia—hyperopia and myopia.

Hyperopia.—This form of eye is commonly known as the far-sighted eye, the eye of nature, and the short eye, as it has its retina closer to its dioptric system than the principal focus. Parallel rays

of light entering such an eye at rest (under the effect of a cycloplegic) do not focus upon its retina, but would focus back of it. (See fig. 24.) Rays of light under similar conditions leaving the macula of such an eye would pass out divergently; hence the hyperopic eye emits divergent rays of light and requires convergent rays of light to meet on its retina when the eye is at rest. When the hyperopic eye is active and not under the effect of a cycloplegic, it must accommodate for all distances, and it is this constant accommodative effort which makes its owner conscious that he has eyes. Such an eye can and does obtain clear, distinct, distant, and near vision, the same as the emmetropic eye, but it must accommodate to do so. To relieve this effort of accommodation and to put this eye in the emmetropic or standard state it is necessary to prescribe a definite strength spheric convex lens which will make the parallel rays convergent and focus on the macula. (See fig. 25.)

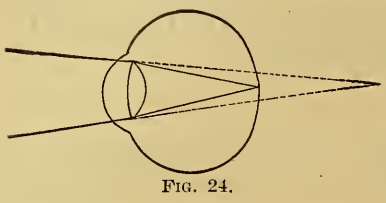

FIG. 24.

Myopia.—This variety of axial ametropia is the exact opposite of the hyperopic eye and is commonly known as the near-sighted eye, the (eye of civilization), and the long eye, as it has its retina farther away from the dioptric apparatus than the principal focus. Parallel rays of light entering such an eye focus and cross in the vitreous (see fig. 26), forming a blurred image of distant objects. Rays of light leaving the macula of such an eye converge and meet at some point closer than infinity, depending upon the amount of elongation of the eye, and the nearer these rays focus to the eye the greater the myopia and the stronger the concave lens which is prescribed to make the emergent rays pass parallel. The myopic eye emits convergent rays of light and requires divergent rays of light to focus upon its retina so that it may be placed in the emmetropic or standard state. The uncorrected myopic eye never has good or standard distant vision like the emmetropic or hyperopic eye. It can not see distant objects with any degree of clearness. It does not use its accommodative power to see at a distance, but has this power in reserve, so to speak, to see minute near-by objects, hence the myopic eye has poor distant vision and good near sight. Figures 27 and 28 show the myopic eye at rest and also with a concave spheric lens in position.

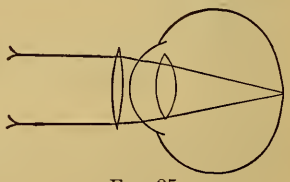

FIG. 25.

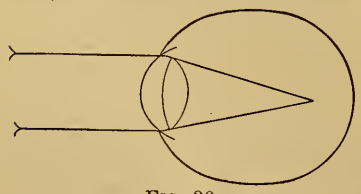

FIG. 26.

Myopic eyes do not usually produce headache from any effort of accommodation as do the hyperopic eyes. The myopic eye gives its owner the consciousness of not being able to see at any great distance without glasses, and yet possesses good near vision.

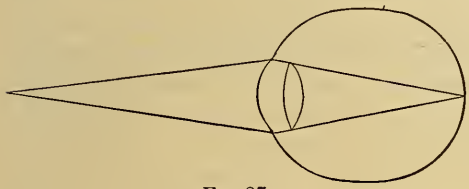

FIG. 27.

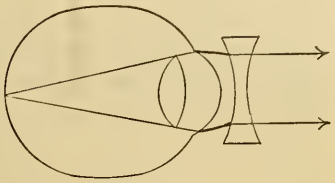

FIG. 28.

Astigmatism.—This is defined as the condition in which rays of light from a point, passing through a lens or series of lenses, do not focus at a point, or astigmatism is that condition of an eye in which there are two principal meridians, of greatest and least ametropia, each having a different focal plane, usually at right angles to each other. As rays of light in an astigmatic eye are not refracted equally in all meridians, the resulting image of a point becomes an oval, a line, or a circle. (See fig. 29). Astigmatism is the condition of the

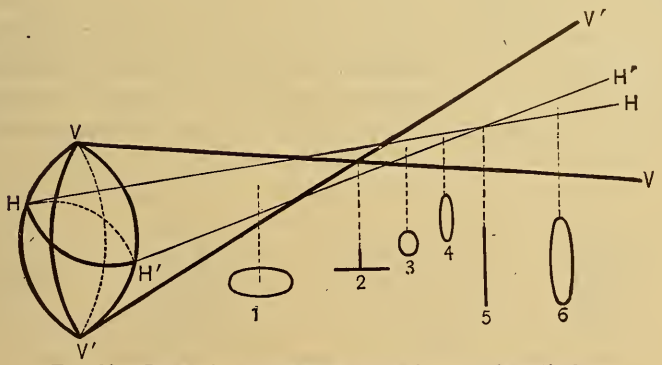

FIG. 29.—Rays of light passing through an astigmatic lens.

eye that deals with the curvature of its refractive system, the cornea, or lens, usually the cornea, but it may be of both these structures in one and the same eye. As it has to do with the curvature of the refractive system, it is also spoken of as *curvature ametropia*. The astigmatic condition is quite common, and exists in greater or less degree or amount in nearly 80 per cent of all eyes.

Small amounts of astigmatism may be ignored by the owner of such eyes, but when the amount is manifest, then objects become more or less blurred or indistinct and visual acuteness is diminished. The

correcting glass for astigmatism is a cylinder lens, and this is one that refracts rays of light in one meridian, and that meridian is always at right angles to the axis of the cylinder.

Figure 30 illustrates parallel rays of light entering an eye, those in the vertical meridian V V, focus on the retina at V′, which is therefore emmetropic; but those in the horizontal meridian fall upon the retina before they can focus at H′, hence it is this horizontal meridian that is hyperopic, and the condition is known as *simple hyperopic astigmatism*. The correcting lens is a plus cylinder at axis 90°,

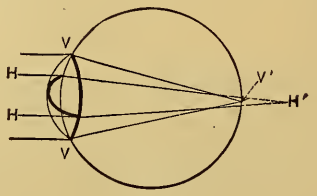

Fig. 30.

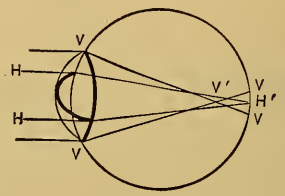

Fig. 31.

which will converge the rays of light in the horizontal meridian and cause them to focus equally with the emmetropic vertical meridian.

Figure 31 illustrates *simple myopic astigmatism*. The vertical meridian V V focuses rays in this meridian before they reach the retina, whereas those in the horizontal meridian H H focus as in an emmetropic eye on the retina, the vertical meridian is refracting too strongly and requires a concave cylinder at axis 180° to make the rays in this vertical meridian focus with the horizontal meridian.

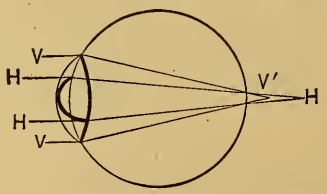

Fig. 32.

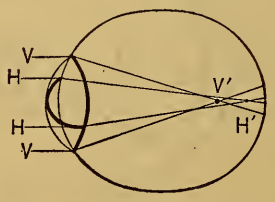

Fig. 33.

Figure 32. This shows both meridians to be hyperopic, the horizontal more so than the vertical; that is *compound hyperopic astigmatism*, the correction lenses being a plus sphere and a plus cylinder. This is a condition of axial ametropia combined with simple hyperopic astigmatism.

Figure 33. This illustrates *compound myopic astigmatism*, the reverse of that shown on figure 32. Both meridians focus in the vitreous, that is, there is an axial ametropia combined with curvature ametropia. The correcting lens is a minus sphere with a minus cylinder.

Mixed astigmatism is illustrated in figure 34. This is a condition in which the retina of the eye occupies the positon where one meridian focuses in front and the other back of the retina. It is a condition that requires a plus cylinder and a minus cylinder at right angles to each other. This combination lens is generally transposed into a sphero-cylinder.

Diagnosis of refractive errors.—The hyperopic eye until it becomes presbyopic, that is, at 50 or more years of age usually enjoys good distant vision, namely 20/20 or nearly so, but maintaining its near point for close work, reading, writing, sewing, etc., causes asthenopia, ocular pains and frontal headaches or fronto-temporal headaches, and these head symptoms usually subside soon after the near use of the eyes is discontinued. A convex spheric lens placed before such an eye gives comfort and improves both the distant and near vision, this is quite a point in diagnosis as the emmetropic and myopic eye have their distant vision impaired when a convex lens is placed in front of them. The near point in hyperopic eyes is always farther away than its age would indicate if the eye were emmetropic; that is, a hyperopic eye 20 years of age and the hyperopia being two diopters, will have a near point of 12.5 cm., whereas if it were an emmetropic eye the near point at this age would be 10 cm. Placing the hyperopic eye under the effect of a cycloplegic (atropin sulphate one-half grain to water 1 dram, one drop in the eye and waiting 2 hours), the plane retinoscopic mirror will reveal a slow movement of the illumination across the pupil with the movement of the mirror in all meridians and placing a plus three diopter sphere before such an eye would give a point of reversal at 1 meter distance if the amount of the hyperopia is two diopters.

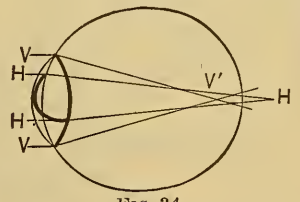

FIG. 34.

The myopic eye always has poor distant vision, less than 20/20 therefore, and much poorer distant vision the higher the amount of the myopia.

The myopic eye always has much better near sight than distance sight and can maintain an amount of close work that would soon weary the hyperopic eye. Myopic eyes, as they do not use much accommodative power, do not produce the same head symptoms that hyperopic eyes do. In fact myopes rarely have frontal headaches from use of the ciliary muscle. As myopic eyes usually have very large pupils, it may not be necessary to use a cycloplegic when using the retinoscope. As the rays of light from the retina of a myopic eye converge to some point closer than 20 feet, and if the amount of

myopia is more than one diopter then this point of convergence (point of reversal) is closer to the eye than 1 meter, hence with the plane retinoscope and the observer at 1 meter, the retinal illumination appears to move in a direction opposite to the movement of the mirror and in all meridians equally. A myopia of one diopter would place this point of reversal at just 1 meter.

The diagnosis of curvature ametropia or astigmatism is determined in many ways. As astigmatic eyes have their emergent rays directed in two different focal planes, the visual acuteness for distance and for near must be correspondingly blurred or indistinct, according to the amount of the astigmatic error. With this understanding it can readily be appreciated why an astigmatic eye must see clearer in one meridian than the meridian opposite to the meridian of clearer sight, and why certain of the letters on the test card must be confused with others of similar shape. Such letters are known as confusion letters, and when miscalled are quite diagnostic of astigmatism. They are: A and R; round letters, O, C, D, G, Q; and square letters, H, M, N, W, N; also E and Z; T, Y, and V. The letters S and B are also confused. Another simple method of detecting astigmatism is to cause the eye to look at a so-called astigmatic chart (Fig. 35).

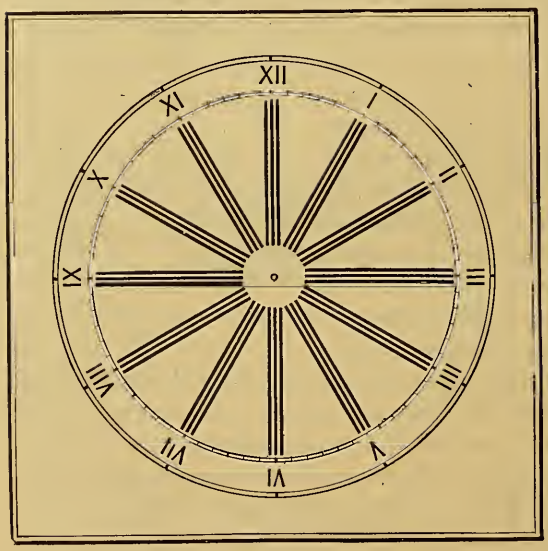

Fig. 35.

This is a series of three equally black lines passing through six chief meridians, and as these meridians are marked and correspond to the numbers or figures on a clock it has received the name of the clock dial, and the patient readily indicates the lines when so informed. An eye that is astigmatic more than half a diopter and has no axial ametropia will promptly detect which lines on the chart appear darker than all the others; however, if there is axial ametropia much greater in amount than the astigmatism, it may be necessary to place a spheric lens before the eye to detect the curvature ametropia by this test. Another excellent method of determining the presence of astigmatism is to place a plus or minus one diopter

cylinder before the eye as the eye looks at the clock dial chart and rotate this cylinder through the various meridians, if the lines which appear darker than all others with this cylinder in position, change to the next succeeding series of lines as the cylinder is revolved, the astigmatic error must be slight or not present. The ideal method of detecting astigmatism is with the plane mirror retinoscope. If the observer is not an expert with the retinoscope it may be necessary to have the eye under the effect of a cycloplegic. (See Diagnosis of hyperopia.) The presence of astigmatism with the mirror is always detected by the appearance of a band of light which extends across the pupil as the mirror is rotated and the light made to pass through first one and then the other of the chief meridians.

This band of light may occupy any meridian depending upon which is astigmatic. If the band moves with the movement of the mirror, then the diagnosis is one of hyperopic astigmatism if the observer is at the regulation distance of 1 meter from the eye under observation; if the band of light moves in a direction opposite to the movement of the mirror, the astigmatism is myopic. There is no better or more exact objective method of estimating the refractive error than with the retinoscope.

APPENDIX.

VISUAL REQUIREMENTS OF RECRUITS AND OF DRAFTED MEN AT NATIONAL ARMY CANTONMENTS.

To determine the acuteness of vision, without glasses, place the candidate with his back to the window, at a distance of 20 feet (6 meters) from the test types. Examine each eye separately, without glasses, covering the other with a card (not with the hand). The applicant is directed to read the test types from the top of the chart down as far as he can see, and his acuteness of vision is recorded for each eye, with the distance of 20 feet (6 meters) as the numerator of a fraction, and the size of the type of the lowest line he can read as the denominator. If he reads the 20 feet (6 meters) type correctly, his vision is normal and recorded 20/XX or 6/6 in meters; if he does not read below the 30 feet type (9 meter type) the vision is imperfect, and recorded 20/XXX (6/9 in meters); if he reads the 15 feet type (5 meters), the vision is unusually acute and recorded 20/XV (6/5 in meters), etc. (Compare with p. 9.)

In accordance with these conclusions, the minimum visual requirements are as follows: 20/XL (6/12 in meters) for the better eye and 20/C (6/30 in meters) for the poorer eye, provided no organic disease exists in either eye.

Men may be accepted for the line of the Army when unable with the better eye to read correctly all the letters on the 20/XL (6/12) line, and when unable with the poorer eye all the letters on the 20/C (6/30) line, provided that they are able to read some of the letters on the line below, and no organic disease exists in either eye.

For the Ordnance, Medical, Engineer, and Quartermaster Departments, the rule is: 20/C (6/30) with each eye, correctible with glasses to 20/XL (6/12), provided no organic disease exists in either eye.

The following visual defects are cause for rejection: Acuteness of vision below the requirements above stated; conjunctival affections, including trachoma and entropion; strabismus; disease of the lachrymal apparatus; exophthalmos; ptosis; permanent asthenopia; nystagmus.

VISUAL REQUIREMENTS OF APPLICANTS FOR DETAIL IN AVIATION SECTION, SIGNAL CORPS.

1. *Question* the candidate carefully regarding *previous or present eye trouble*, use of glasses, headaches, lachrymation, scotoma, and photophobia; also diplopia (muscæ volitantes panorama symptoms), glaucomatous symptoms, night blindness or asthenopia when not wearing correcting lenses. Any one of the latter group disqualifies, and also of the former group if marked. Note findings.

2. *Stereoscopic vision* is the ability to appreciate depth and distances by means of binocular single vision. Objects printed on the test cards furnished for use with the stereoscope are drawn to scale; the distance between corresponding points of similar objects are *equal;* between dissimilar objects, unequal. They are seen at different apparent depths, the result of superposition of each two similar images in space; the less the distance between the objects, the nearer they appear to the observer's eyes, the greater the distance between, the farther away they appear. A normal eye can appreciate an apparent difference in distance between stereoscoped objects of 0.01 mm. Adjust the oculars of the stereoscope at their focal distance (15 cm.) from the glass stage and rotate by means of the milled edge on either ocular cup so that the interpupillary distance will be as great or greater than the distance between any two similar points of objects to be stereoscoped. With good illumination, have the candidate name the sequence of objects from front to rear as he sees them through the stereoscope. This should be done readily and without error, otherwise it is a cause for rejection.

3. *Ocular movements* are tested roughly by requiring both eyes of the candidate to be fixed on the examiner's finger, which is carried from directly in front to the right, to the left, up, and down. The movements of each eye must be regular and identical.

4. *Pupillary reactions* should be regular and equal in each eye when responding to (1) direct and (2) indirect light stimulation and (3) to accommodation. Face the candidate and place a card as a screen before both eyes. Uncover one eye after a short interval and allow light to shine in this eye. The resulting contraction of the iris of this eye is called *direct.* Repeat, but now observe the shaded eye. This reaction is indirect or *consensual* of the shaded eye. Repeat for the other eye.

With both the candidate's eyes open and uncovered, have him *fix* on a pencil held a few inches directly in front of him. Bring the pencil toward him until it nearly touches his nose. Both irises will contract, which is called the *reaction to accommodation.*

5. *Intraocular tension* is tested roughly by palpitation. The candidate looking downward, palpate the eye through the upper lid

with the index finger of each hand, and compare the tension with the other eye and with an eye believed to be normal. If not normal, it is a cause for rejection.

6. *Any visible lesion* of the eye is determined by having the candidate near to and facing a well illuminated window and assisted by the use of a hand lens. The eyes should be free from disease, congenital or acquired, such as lesions of the cornea, iris, or lens, including affections of surrounding structures, such as pathological conditions of the lachrymal apparatus, conjunctival deformities, or any other affection which would tend to cause blurring of vision if the eyes, unprotected by glasses, were exposed to wind or other unfavorable atmospheric conditions.

7. *Ocular nystagmus* is determined, and if it is rhythmical and occurs—(*a*) and (*b*)— on looking straight ahead or laterally, 40 degrees or less, it is a cause for rejection.

(*c*) *Spontaneous ocular nystagmus* produced by extreme lateral sight, 50 degrees or more, is not a cause for rejection, as it is found in the normal individual. It is usually manifested by a few oscillating lateral movements, never rotary, which appear when the eyes are first fixed in extreme lateral positions. Select a scleral vessel near the corneal margin as a point for observation.

8. *Field of vision* is tested separately for each eye. Place the candidate with his back to the source of light and have him fix the eye under examination (the other being covered) upon the examiner's, which is directly opposite at a distance of 2 feet. The examiner then moves his fingers in various directions in a plane midway between himself and the candidate, until the limits of indirect vision are reached. The examiner thus compares the candidate's field of vision with his own and can thus roughly estimate whether normal or not. A restricted field of vision should be confirmed by the use of a perimeter, as it would then be a cause for rejection.

9. *Color vision* should be normal for red and green. A Jenning's test set is preferred. If not available, then select a skein of any shade of red or green worsted and have the candidate select, in separate piles, all skeins containing red or green. If confusion, colored lights at 20 feet should be used as a test before rejecting.

10. *Muscle balance at 20 feet.*—If available, a phorometer should be used to determine the presence or absence of a muscular imbalance. Adjust the phorometer close to and in front of the candidate's eyes, at 20 feet distance from a lighted candle or other small point of light on the same level. Darken the room and arrange the prisms so that their bases are situated inward; two images of the light will then be seen displaced laterally. If on a level, there is a normal balance of the vertically acting extrinsic eye muscles or orthophoria;

if not on the same level, there is vertical imbalance or hyperphoria; left, if the left image is below, right hyperphoria, if the right image is below. Read off on the scale the amount necessary to bring the images on the same level.

Repeat the test with the prisms, one up and one down. If the images now are directly above each other there is no lateral imbalance, but if laterally displaced and on the same side with the eye seeing each image, there is homonmous diplopia due to a lateral imbalance called *esophoria*. If the images are crossed there is *exophoria*. Read off on the scale the amount necessary (prism diopters) to bring them in the same vertical meridian. If not more than one (1) degree of hyperphoria and more than two (2) degrees of esophoria or exophoria, the test is satisfactory.

11. *Visual acuity.*—(*a*) Acuity for distance tested at 20 feet from a well illuminated Snellen test card, if less than 20/20 in either eye, tested separately, disqualifies.

(*b*) Near point, or acuity for near vision, is determined separately for each eye by requiring the candidate to read in a good light the Jaeger No. 1 test type, first gradually bringing the card toward the uncovered eye until the nearest point to the eye, at which the test type still remains distinct, is reached. The distance of this point from the anterior surface of the cornea, measured in centimeters, is the near point. Greater than 11 cm. at 20 years of age, greater than 13 cm. at 25 years of age, or greater than 15 cm. at 30 years of age, disqualifies.

12. *Ophthalmoscopic findings.*—Drop one drop of a 5 per cent solution of euphthalmine in each eye. Have the candidate keep his eyes closed. After 15 minutes repeat the drops, then examine 15 minutes later. A pathological condition of the fundus, active or quiescent, is cause for rejection.[1]

VISUAL TESTS FOR THE DETECTION OF MALINGERERS.

Malingerers who wish to evade military service by feigning impairment of vision may be divided into two classes as follows:

A, those who claim total loss of vision in one eye.

B, those who claim partial loss of vision in one or both eyes.

Either group may have a normal acuity of vision or may exaggerate a defect actually present.

In testing for malingering the medical examiner should bear in mind that detection is more likely to result when the man is allowed to believe that his case is regarded from the first to be genuine and that his story is not discredited. There is something indefinable in the bearing of the malingerer which experience alone can detect. He

[1] These requirements and the methods detailed may be compared with Chapter I of this manual.

may be self-assertive and over-confident; he may be hesitating or evasive. Careful observation should be made of his conduct and every movement noted. The nature of the man's answer should be taken into account and considered in the light of the kind of reply that is given when a genuine refraction case is being dealt with.

EQUIPMENT.

The following equipment will be supplied :

(*a*) Trial frame; 1 blank; spherical lenses, +16, +3, +0.25, −3, −2, −1, −0.25 (to be found in regular medical corps equipment).

(*b*) Two prisms, one 6°, one 10° (in regular equipment).

(*c*) Ophthalmoscope (electric battery in handle).

(*d*) Condensing lens.

(*e*) Loupe.

(*f*) Red and green letters on glass: (*a*) letters varying in size; (*b*) spectacle frame containing red and green glasses.

(*g*) Special test cards, one a duplicate, with letters reversed to use with a mirror.

(*h*) Mirror large enough to reflect test card.

(*i*) One stereoscope with special cards.

(*j*) Retinoscope (electric, with battery in handle).

(*k*) Ruler, about one and one-quarter inches wide.

METHODS OF EXAMINATION.

Class A. Total loss of vision in one eye.

(*a*) A 6° prism base downward is placed before the admittedly sound eye, while the man looks at a distant light or candle; if he sees two candles, binocular vision is proved. The examiner may vary the test by placing the prism before the "blind" eye, either base up or base down.

(*b*) A prism of 10° with base outward is placed before the "blind" eye. If there is any sight in this eye, double vision will be produced, and the eye will be seen to move inward to correct it and fuse the two images.

(*c*) The alleged "blind" eye is covered. A prism of 10° with the apex up is placed before the seeing eye in such a position that its edge lies horizontally across the center of the pupil. This produces monocular diplopia. The prism is then moved upward so as to be completely in front of the good eye and at the same time the "blind" eye uncovered. If diplopia is produced or admitted, there is sight in the "blind" eye.

(*d*) **Test with colored glasses and letters.**—This consists in directing the individual to read a row of red and green letters through a red

and green glass. The red letters will be invisible to the eye that has the green glass before it and vice versa, but if all the letters are correctly read irrespective of their color, there must be sight in the "blind" eye. Further, the smallest letters correspond with the 20/40 test letters, and if read at 20 feet indicate vision up to standard. To determine this, reverse the glasses and direct the letters to be read. As these letters are seen by transmitted light, the proper illumination back of the chart must be observed.

(*e*) **Test with trial glasses.**—A high plus glass is placed before the good eye and a low plus or minus before the "blind" eye. If the distant type is read, the vision in the "blind" eye is good.

(*f*) **The stereoscopic test.**—This may be made with ordinary stereoscope, the printed matter so arranged that certain portions of it are not present before one or both eyes.

(*g*) **The bar test.**—Interpose a ruler about 1¼ inches wide vertically midway between the two eyes at about 4 to 5 inches distance; direct the man to read from a printed page with lines at least 4 inches long. If able to read the lines, binocular vision exists.

(*h*) The action of the pupil must be carefully tested, there usually being no movement to light stimulation when the eye is blind.

If the examiner is not satisfied, the following examination should be made:

(*a*) **Oblique examination.**—A careful examination of the cornea should be made with the aid of a condensing lens and loupe.

(*b*) **Ophthalmoscopic examination.**—A searching examination with the ophthalmoscope should be made, together with an estimation of the refractive error. The pupil should be dilated if necessary.

Class B. Partial loss of vision in one or both eyes. Men pleading this disability may be divided into two classes:

(1) Those who pretend to have a visual defect.

(2) Those who are aware that they have a visual defect and exaggerate its effect.

No hard and fast tests can be prescribed for the detection of these cases. Much depends on the alertness and ingenuity of the medical examiner.

The tests with prisms are not applicable here, for there is not pretended blindness in one eye, but simply an alleged diminution of visual acuity.

(*a*) **Mirror tests with special test cards.**—(See equipment No. 7.) Test cards are used which are identical, one having the letters reversed. The recruit is directed to read the letters on the chart across the room, and then in a mirror beside it, which reflects reverse letters that are placed over his head. The letters seen in the mirror are

located double the distance of the direct letters from the man being examined. The malingerer is apt to read in the mirror the line which he read on the first card, showing that his vision is twice as good as he pretends.

(*b*) **Trial frame test.**—Place a trial frame upon the man's face and put before the sound eye a high convex lens (+16D), and before the "blind" eye a plane or weak lens (+0.25), which will not interfere with vision. If letters placed at a distance of 20 feet are read, the fraud is at once exposed.

(*c*) Oblique examination with condensing lens and loupe to determine corneal or lenticular opacities.

(*d*) **Ophthalmoscopic examination.**—It is probable that the malingerer will resist the ophthalmoscopic examination by frequent winking or rolling of the eyes. In this event it is best to caution the man that a report of his vision must be made, and then to postpone further examination until after the next few recruits have been examined.

(*e*) Estimate the refractive error with the use of the ophthalmoscope. If no error of marked degree exists and the media and fundi are normal, the relation between the alleged vision and the refractive condition furnishes an important clue. If the error is about +4.00 or —2.00 the visual acuity could be about 20/100, but when the defect can not be accounted for objectively and the vision is brought from 20/100 to 20/50 or 20/30 by means of a low plus or minus glass, the man is malingering.

(*f*) **Retinoscopy.**—Look for corneal and lenticular opacities and estimate refractor errors.

Occupation.—The man's occupation in civil life may have been such that it could not have been followed without more vision than he claims.

In the absence of ocular defects continuous and persistent blepharospasm, the use of colored glasses, eye shades, or eye bandages should be regarded with suspicion.

Diplopia.—Cases of malingering are occasionally met with in which the man complains he sees double. These must be investigated with the application of the ordinary tests as if they were genuine, with every precaution taken to guard against a serious lesion being overlooked.

By order of the Surgeon General:

H. P. Birmingham,
Colonel, Medical Corps.

FORMULARY.

ANTISEPTIC AND CLEANSING LOTIONS.

1. Boric acid, 4 per cent. or ℥ss (or gm. 20) to Oi (or gm. 500).
2. Sodium chlorid, 0.6 per cent. or ℥i (or gm. ℥) to Oi (or gm. 500).
3. Equal parts of boric acid and physiologic salt solution.
4. Bichlorid of mercury from 1–10,000 to 1–5,000; gr. i–Oi.
5. Cyanid of mercury, 1–5,000.
6. Irrigating, slightly antiseptic and cleansing fluids, useful in all forms of conjunctival irritation and inflammation.

℞. Ac. boric, grs. xx or gm. 1.3.
Sodii bibor., gr. xvi or gm. 1.
Aq. distill., f℥iv or mils. 120.
S. Eye lotion.

℞. Ac. boric, gr. xii or gm. 0.78.
Sodii bibor., gr. x or gm. 0.65.
Aq. camph., ℥ii or mils. 8.
Aq. distill., f℥iv or mils. 120.
S. Eye lotion.

℞. Ac. boric, gr. x or gm. 0.65.
Sodii bibor., gr. xv or gm. 1.
Glycerin, ℥i or mils. 4.
Aq. distill., f℥iv or mils. 120.
S. Eye lotion.

℞. Ac. boric, gr. xx or gm. 1.3.
Sodii chlor., gr. xii or gm. 0.78.
Adrenalin chlor., m. xv or mil. 1.
Aq. distill., f℥iv or mils. 120.
S. Eye lotion for relief of epiphora and lachrymal conjunctivitis.

℞. Sodii bibor., gr. xxi or gm. 1.
Chloretone, gr. vi or gm. 0.4.
Aq. distill., f℥iv or mils. 120.
S. Eye lotion.

℞. Sodii bicarb., gr. x=gm. 0.65.
Sodii bibor., gr. xii=gm. 0.78.
Aq. camph., f℥i=mils. 4.
Aq. distill., f℥iv=mils. 120.
S. Eye lotion.

ASTRINGENT REMEDIES.

℞. Zinci sulph., gr. iv or gm. 0.26.
Aq. distill., f℥iv or mils. 120.
S. Five drops in each eye three times a day.

℞. Zinci sulph., gr. iv or gm. 0.26.
Ac. boric, gr. xx or gm. 1.3.
Aq. distill., f℥iv or mils. 120.
S. Eye lotion.

The above lotions are particularly useful in chronic conjunctivitis caused by the Morax Axenfeld bacillus. Camphor water may be added to these lotions, as well as glycerin, in the manner shown in the previous formulas.

℞. Zinci sulph., gr. ii or gm. 0.13.
Sodii bibor., gr. xvi or gm. 1.
Aq. distill., f℥iv or mils. 120.
S. Five drops in each eye three times a day.

℞. Ac. tannici, gr. i or gm. 0.065.
Sodii bibor., gr. xvi or gm. 1.
Aq. camphor, f℥i or mils. 30.
Aq. distill., f℥iii or mils. 90.
S. Eye lotion.

Usually tannic acid is applied to the everted lid, for example, in trachoma, with a cotton mop, as follows:

℞. Ac. tannici, grs. xx–lx or gm. 1.3 to 2.6.
Glycerini, f℥i or mils. 30.
S. Paint on everted lids.

℞. Sodii bibor., ℥iiss or gm. 10.
Glycerini, f℥i or mils. 30.
S. Paint on everted lids.

℞. Cupri sulph., gr. i–v or gm. 0.065 to 0.32.
Glycerin, f℥i or mils. 30.
S. Paint on everted lids in trachoma.

℞. Argenti nitrat., grs. v–x or gm. 0.32 to 0.65.
Aq. distill., f℥i or mils. 30.
S. Paint on everted lids in mucopurulent conjunctivitis; the stronger solution in purulent conjunctivitis, and neutralize excess with physiologic salt solution.

In place of silver nitrate may be used argyrol, 25 per cent. It has no germicidal qualities, but is detergent and penetrating. Protargol, 10 per cent. It resembles argyrol, but has distinct germicidal properties; is, however, quite irritating.

SALVES.

1. Ung. acid borici (officinal strength).

℞. Hydrarg. oxid. flav., gr. i or gm. 0.065.
Vaselin albi, ℥i or gm. 4.
S. Eye salve.

℞. Hydrarg. oxid. flav., grs. ii or gm. 0.13.
Lanolin, ℥i or gm. 4.
Petrolat, ℥i or gm. 4.
S. Eye salve.

℞. Ichthyol, gr. vi or gm. 0.4.
Vaselin, ℥ii or gm. 8.
S. Apply to edges of lids after cleansing. Useful in blepharitis.

℞. Ichthyol, grs. x or gm. 0.65.
Ung. zinci ox., ℥ii or gm. 8.
S. Eye salve. Useful in blepharitis.

Bichlorid of mercury 1–3,000; often used in form of White's ointment.

℞. Hydrarg. bichlor., gr. 1/6 or gm. 0.01.
Sodii chlor., gr. 5/6 or gm. 0.05.
Alcohol dil., q. s.
Petrolati albi., ℥i or gm. 30.
Dissolve sublimate and salt in a few drops of dilute alcohol and mix with the vaselin, which has previously been kept at a temperature of 212° F. for half an hour. Stir until cool.

DUSTING POWDERS.

The ones most used are calomel in phlyctenular keratitis; also in this and similar diseases nosophen; finely powdered idoform, useful in infected ulcers; aristol, acts like iodoform. These substances may be used also in the form of ointments in 2–4 per cent strengths.

MYDRIATICS AND MYOTICS.

1. **Atropin sulphate** is usually employed in a strength of 4 grains (0.26 gm.) to the ounce (30 c. c.). A drop of such a solution dilates

the pupil in about 15 minutes in a normal eye, and a very few minutes later begins to paralyze the accommodation, which sustains a full paralysis in about two hours. The effect of atropin upon the accommodation remains for a week, but if the drug is used for several days at a time, the return to the previous power of accommodation is not secured for about 12 days.

2. **Hyoscyamin** is usually employed in a strength of 2 grains (0.13 gm.) to the ounce (30 c. c.). It produces wide dilatation of the pupil and complete ciliary paralysis, the effect of which lasts from six to seven days in the normal eye.

3. **Duboisin** is used in the same strength as hyoscyamin. The return to accommodative power takes places in from four to five days.

4. **Homatropin hydrobromid** has a comparatively transitory effect upon the ciliary muscle, full return to accommodation occurring in about 50 hours after the last instillation. To use this drug properly, for example, in the measurement of refractive errors, it should be employed by cumulative instillations in the sertngth of 8 grains (0.52 gm.) to the ounce (30 c. c.) one drop of such solution being used every 15 minutes for an hour and a half preceding the determination, and then waiting 40 minutes. At the end of this time the maximum effect of the drug upon accommodation is secured.

5. **Scopolamin hydrobromid** is employed in a strength of 2 grains (0.13 gm.) to the ounce (30 c. c.). Mydriasis begins in 12, and is complete in the normal eye in 30 minutes. Cycloplegia occurs in about 45 minutes. Full return to accommodation may be expected in from five to six days. Both duboisin and scopolamin are apt to produce toxic symptoms, and must be used carefully.

6. **Euphthalmin** is an active mydriatic in a 5 to 10 per cent solution. It produces maximum dilatation of the pupil in about 15 to 20 minutes and the pupil returns to its normal size in five to six hours. It has practically no effect on the ciliary muscle.

7. **Hydrochlorid of cocain,** in addition to its anesthetic action, is in 2 to 4 per cent solution a good mydriatic. It has such a slight effect upon accommodation that it is of no material value in estimating errors of refraction.

8. **Eserin salicylate** or **sulphate** is usually employed to control acute rises of intraocular tension in a strength of from 1 to 4 grains (0.065–0.26 gm.) to the ounce (30 c. c.) and *pilocarpin hydrochlorate* in a strength of from 2 to 5 grains (0.13 to 0.324 gm.) to the ounce (30 c. c.). Of the two pilocarpin is less irritating, but also less active, in its miotic influence.

Local anesthesia and analgesia.—1. **Cocain.**—Hydrochlorate of cocain is usually employed in a 2 or 4 per cent solution. A 10 per cent solution has been advised in the operation of curetting lupus and

similar growths. General anesthesia is more satisfactory. Cocain causes drying and roughening of the corneal epithelium. This may be partly avoided by keeping the lids closed after each instillation.

2. **Novocain,** although inferior to cocain as an ocular anesthetic, has certain advantages in that its solutions may be sterilized by boiling, and it is much less toxic. It may be used in a 1 or 2 per cent solution and is employed with advantage in infiltration anesthesia. For this purpose it may be combined with adrenalin.

3. **Eucain** may be obtained in the form of hydrochlorate of eucain A, which in 2 per cent solution is an efficient anesthetic, but produces disagreeable congestion of the conjunctiva, and in the form of hydrochlorate of eucain B, which is related to eucain A and also to cocain and tropacocain. It is not decomposed by boiling, and in 2 per cent solution is an active anesthetic which does not dilate the pupil and is said not to cause clouding of the corneal epithelium.

4. **Holocain.**—A 1 per cent solution of this drug causes anesthesia in from 15 seconds to 1 minute, which lasts for about 10 minutes, preceded by a moderate burning sensation. It is an admirable local anesthetic and its solution does not enlarge the pupil, does not affect accommodation nor increase intraocular tension, and is said to possess bactericidal properties. It is preferred by many surgeons to cocain in operations on the eyeball—for example, cataract extraction. A mixture of cocain and holocain is also employed.

5. **Acoin.**—This drug is related to caffein and theobromin, and is an active local anesthetic in unirritated eyes in solutions of 1:100 and 1:300. It has no effect upon accommodation, the size of the pupil, and does not increase intraocular tension or cloud the corneal epithelium. In congested eyes even repeated instillations of acoin do not produce satisfactory anesthesia.

6. **Stovain.**—This drug in 4 per cent solution, dropped on the conjunctiva, causes smarting, burning, and lacrimation, followed by anesthesia, which lasts for about five minutes. It has little or no influence on the pupil and does not cause paresis of accommodation. In aqueous solution it is not altered by boiling, which renders its sterilization convenient. It has also been used as an injection into the tissues to produce local anesthesia.

7. **Alypin.**—This synthetic compound is a glycerin derivative. A 2 per cent solution instilled into the conjunctival sac causes slight smarting, some dilation of the superficial vessels, especially those around the cornea, and anesthesia, which is evident in about one minute. It apparently does not dilate the pupil, and is said to have no influence on accommodation.

8. **Dionin.**—This is a morphin derivative, which produces, a few seconds after its instillation into the conjunctival sac, smarting, burning, stinging, and marked edema of the conjunctiva, especially of that of the bulbar expansion. Occasionally the lid participates in the swelling, and not rarely the "dionin reaction" is severe. Soon the eye establishes immunity, and after a few applications on succeeding days the reaction is little marked and sometimes does not take place. Within 20 minutes the edema of the primary reaction subsides and analgesia appears, which may last for several hours. The drug is a lymphagogue, an analgesic, and probably has some influence in altering and conserving the nutrition of certain tissues—for example, the cornea. Its lymphagogue action is the important therapeutic one. Its indications have been described with the various diseases, and it is especially valuable in the treatment of certain types of ulcerative and parenchymatous keratitis, iridocyclitis, and glaucoma. The drug should be employed in a solution varying in strength from 1 to 5 per cent, according to the indications, from once to four times per diem until immunity is established; the drug is now discontinued for three days; at the expiration of this time a modified reaction will again usually appear. If it is urgent that the drug shall be continued after immunity is established, the strength of the drug may be increased, but not beyond 10 per cent. It may also be employed in salve or powder. It is an exceedingly valuable remedy; occasionally it produces serious reaction; rarely it aggravates existing conditions, especially if the patients are the subjects of arteriosclerosis and renal disease. The value of the drug may be enhanced by preceding its application with holocain and following it with adrenalin chlorid. Dionin, although an analgesic, is not a local anesthetic, and in that sense does not belong to those drugs which are used to produce insensitiveness of the tissue with which they come in contact.

Anesthesia by means of subcutaneous injections.—In lid operations cocain solution (1 to 2 per cent) or novocain solution may be injected beneath the skin (holocain can not be used for this purpose), or the so-called infiltration anesthesia may be tried. This consists of an *intracutaneous* (not subcutaneous) injection with a hypodermic syringe , or with one specially devised for the purpose, of a 0.2 per cent solution of sodium chlorid, which is reinforced by the addition of from one one-hundredth to one-fiftieth of 1 per cent of cocain. The fluid injected produces edema, and the anesthesia is strictly limited to the edematous area.

A mixture of beta-eucain and cocain may be employed for local anesthesia, and very satisfactory results can be produced with beta-

eucain and adrenalin-chlorid. Arthur E. J. Barker's solution is as follows:

	Gm.
Pure chlorid of sodium	0.8
Beta-eucain	0.2
Adrenalin-chlorid	0.001
Distilled water	100.00

The efficiency of this solution can be still further enhanced by adding cocain. A 1 per cent solution of cocain to which 4 minims (0.24 c. c.) of adrenalin (1:1,000) are added is a useful mixture for local anesthesia. Pooley recommends the following formula: Alypin, 15½ grains (1 gm.); sodium chlorid, 12 grains (0.78 gm.); adrenalin, 10 minims (0.6 c. c.); distilled water, 3½ ounces (104 c. c.).